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Contents.

	PAGE
Notes and Comments	599
National Physical Laboratory	601
Pattern-Making	602
Effect of Temperature on Tensile Tests of Copper and its Alloys	608
Effect of Temperature on Ductility of Zinc	608
Making Double Flanged Pulleys from Standard Pulley Patterns.—I.—Pulleys with External Flanges	609
The Testing of Moulding Sands	610
Gates for Moulds	615
The Influence of the Shape of Test Bars on the Mechanical Properties of Cast Iron	616
Coking Practice in the South Wales District	618
Impurities in "Tough-Pitch" Copper	623
New Process for Casting Ingots	624
Tests of White Metals	625
Cardiff Convention of British Foundrymen's Association	626
Foundry Plant and Equipment	629
The Denison-Korte Briquetting Machine for Metal Borings	630
Electric Transformer Crucible Furnace	631
A New Combination Moulding Machine	632
Modern Cupolas	633
Inventions	634
Trade Talk	637
Queries	638
Personal	638
New Companies	640
Deaths	642
Prices of Metals	642

Forthcoming Event.

OCTOBER 11.

British Foundrymen's Association (London Branch).—"Education in Relation to the Status of the Foundry," by Alexander Hayes (London).

NOTES AND COMMENTS.

Mutual Recrimination.

Probably one of the most acceptable features, to the foundryman, of the anxieties and worries that are strewn across his daily pathway, is the fact that while he is continually being blackguarded by other departments for his numerous sins, he can at least claim to insert a few thorns in the rosy beds of the other departments in question. The feud between foundry and machine shop, born mainly of that prolific parent ignorance, has flourished intermittently for years, and mutual recrimination is accepted as a normal phase of procedure when everything is not just right. But lest it should be imagined that any dull decadence in this direction has set in as the result of modern enlightenment, a machinist correspondent sends us an effusion which may be taken as a bold refutation of any such suggestion. Since he signs himself "A Victim," we are left in wonder just what size of a mess he made of that wicked foundryman's product which formed the last straw and burst the bonds which held his accumulated recrimination fast. But let us proceed with a few quotations, which will at least indicate the rigid economy in love exercised:—

"The foundry is but a necessary evil, designed to try the patience of even a Job, and incidentally to provide all requisite excuses for the non-delivery of work. The dusky denizens of the foundry possess but one overmastering ambition—to render the task of a machinist as difficult as possible, to induce in him an overwhelming desire to cultivate the use of the vulgar tongue, and to embitter him against his fellow beings. The machinist calls a casting a casting, and a moulder a moulder, only when the article can be conveniently chucked, when it is as soft as cheese, and when blow-holes are only conspicuous where there is no machining. Otherwise the former is an un-nameable abortion, and its creator thereof just a 'blinking, chump-headed sand rat.'"

So far this is very mild, and contains the damaging admission that the machinists' sole consideration is the softness of the casting, regardless of its strength or other qualities. But to proceed:—"One is led to wonder whether, when benign Providence took in hand the creating of a moulder, he did not stop half way—perhaps giving up the task in hopeless disgust—and leave the rest of the process for less capable and more wily hands to perform. From what other source can come the inherent cussedness, the perverse desire to do things by contrariwise, the impish delight with which a moulder will gloat over a machinist's discomfiture when he is in trouble over a hard casting, the unholy glee in which he will indulge when a casting is returned to be re-made through a slip of the machinist's? There can be but one conclusion—God made the sand, and the Devil made the moulder."

At this point our more academically-inclined readers may be tempted to indulge in a discourse on evolu-

tion as opposed to direct creation, and point out how environment and long suffering has developed in the moulder certain qualities quite foreign to his naturally amiable disposition; but such sophistry is discounted by a trite illustration of foundry conduct:—"Bob, the turner, pays a surreptitious visit to the foundry to beg of Joe, the sand artist, to leave just a 'leetle bit' more machining on the next valve casting, as the last one would barely clean up. 'Right-ho,' says the grimy one, with his tongue in his cheek. Then when the other is gone he grins evilly, and, bending over his task once more, mutters savagely: 'Wants more metal here, does 'e? By gum, he shall have it. If I put 'im enough he can't grumble next time; 'e can take off what 'e don't want.' Then in goes his trowel with a devilish lunge, and the 'leetle bit' of extra machining comes out a moulder's trifle—an inch!"

The Moulder's Little Way.

We had almost covered our faces in shame at being thus exposed in our wickedness, but, hardening our hearts, we read on:—"Why, unless it be at the prompting of the Evil One, will a moulder laboriously scheme to lay in a core for a hole in a casting which is far better drilled, and omit the very one a drill cannot reach? Why will he persist in pouring a casting the tooling side up when it can just as well be done the reverse way, if not for a ghoulish delight in beholding his handiwork suffering all the horrors of malignant small-pox? Why will he use his round-edge smoother on a corner that requires keeping sharp, and his square smoother where a radius is wanted, if not to give the machine shop a problem? Why will he cast up the very piece to-day you will not be wanting until next week, and leave the one he well knows your machine is standing for? Why, if he has ten castings of a sort to make, does he complete nine and then leave the other until your machine is set up for an altogether different job? Who but a moulder has the ability to so glibly promise you a job to-night and then the colossal effrontery the next morning to tell you that 'it will be ready when it's done?' For your muttered maledictions and your ruffled temper he cares not a rap; and when, at length, you audibly consign him and all his works to a region where molten metal is supposed to be always ready, he merely grins inanely, and calmly advises you to go away quietly somewhere and rest your face."

To answer this volley of questions, even if we tentatively acquiesced to the charges implied, would require too long. Instead, let us ask the machinist why the design as sent to the foundry should so frequently display utter ignorance of the principles of founding. Why is the moulder cursed for an idiot when he attempts to use his brains to overcome another department's ignorance or neglect to issue instructions as to what is required? Why is the moulder expected to so control, mould and reverse the laws of nature as to meet every unreasonable demand of the drawing office, machine shop and testing room alike? Why will the machine shop so persistently demand sharp corners (with their inevitable weak crystallisation) whether necessary or not, or merely to save a few minutes' machining? We might continue the list indefinitely were we so disposed, but we will be content with one final question: Why should the foundry be expected to have greater flexibility in its capacity, and to meet the demands of every other department, reason or none, when its conditions of operation are less standardised and far more liable to accident, unforeseen troubles and other hindrance, than any other department?

To return, however, to our correspondent, we are treated to another illustration of the foundryman versus machinist problem:—"The machine shop foreman interviews the foundry ditto, respecting a set of castings which have to be specially sound, of good, soft, grey metal, and as free from draws and blowholes as a casting sometimes is when an accident happens. Of course, the supervising sand shoveller promises all manner of delightful results, and then enters upon a long and learned dissertation respecting the quality and quantity of hematite he can, with safety, use in the mixture, in order to ensure the fulfilment of these rosy promises. Away goes the machine shop boss, blissfully optimistic, hugely cheered, altogether forgetful of past battles. But with his finger placed obliquely to one side of his nasal organ, and a suppressed chuckle escaping him, the foundry boss strolls off to find Bill, the furnaceman. 'Bill,' he says, 'haven't we got some of that special scrap left—you know the sort I mean, brake blocks, plough shares, chilled rolls, and so on, which I told you some time ago to put away carefully against we want it? You see, Bill, we've got to turn out a special line of castings, some deuced awkward corners in 'em, too—draw like the very blazes if we don't put in a good, strong mixture. I'll let you know when we come to 'em.' Then off he goes, sighing, like Alexander, of old, for fresh worlds to conquer, little caring that he is widening the breach which will alienate the sympathy of the machine shop for all time."

The Only Solution.

What defence can the guilty foundryman offer to such an indictment? Obviously none; for, as our correspondent explains, it is simply his nature so to do; and who would doubt the word of the precision expert so accustomed to exactitude in every operation? We are told, further, and in conclusion of this cheerful epistle:—"There are some words in the otherwise-extensive vocabulary of a moulder that are never used. The individual isn't breathing who has heard one confess that 'it was my fault.' Oh, no; either the pattern sprung the sand wasn't ground properly, the core lifted or wasn't dry, or the metal was cold, etc., etc. It is generally admitted that the exception proves the rule. There was once a jewel of a moulder, who was never heard to use profane language, sing indecent ditties, listen to scandal, sneer at a poor, unfortunate machinist down on his luck, proffer cheap and useless advice, deride his mates, cheek his foreman, or make excuses. This moulder was deaf and dumb."

We know, at last, that the moulder is a hopelessly abandoned creature, created by the spirit of evil, and operating only for the torment of the rest of engineering humanity. We have often suspected he was something more than human to stand the undesirable conditions and abuse to which he is so often subjected; but now we know exactly the reason—he was made it. Have we not the word of the machine shop in support of the assertion?

That being the case, then, the moulder is no longer to be countenanced in the great engineering industry; he is but the creator of trouble and must be dispensed with. Why not inaugurate a national movement for the suppression of moulders? It is evidently a crying need of the times. As a final suggestion, and in order to smooth the path of the machinist and make amends for past wrongs, he shall be allowed—nay, even compelled, should his natural modesty deter him—to go into the foundry, make his own moulds, melt and pour his own castings. Then they will surely be right. We can see no other solution to the problem.

National Physical Laboratory.

Visit by London Foundrymen.

On Saturday, September 28, a party of members of the London Branch of the British Foundrymen's Association paid a visit to the National Physical Laboratory, Teddington, when members of the staff kindly conducted them over the engineering and metallurgical departments, and also the William Froude national tank for testing the resistance, trim or wave-making of ship-shaped forms.

In the Engineering Department there was much of interest to be observed, including numerous apparatus for testing materials of construction, for research work on aeronautics, and other purposes. The greater interest, however, was displayed in the Metallurgical Department.

The work of this Department includes:—(*a*) Metallurgical research and investigatory testing involving the application of the microscope, the pyrometer and of other physical and chemical methods to the study of metals. The investigatory testing deals chiefly with cases of failure occurring in practice which are referred to the Laboratory and dealt with jointly by the Metallurgy and Engineering Departments. The researches of the Department are directed to the study of important groups of alloys (chiefly in connection with the Alloys Research Committee of the Institution of Mechanical Engineers) and to the elucidation of the structure and constitution of metals and alloys generally. (*b*) Chemical analysis of railway and other material for Government Departments and (*c*) chemical analysis, principally of metals and alloys required in connection with the research work of this Department and with the work of the Laboratory generally. (*d*) Chemical work connected with Aeronautics.

The whole Department is now housed in the new Wernher Building and in the adjoining building containing the laboratories for metallurgical chemistry. The Wernher Building consists of a double-storey block measuring approximately 50 ft. by 100 ft., with a workshop and foundry attached, while a single-storey wing connects with the chemical laboratories. The ground floor of the main block is principally devoted to the cutting, grinding, polishing and etching of metal sections and their subsequent examination and photography by means of the microscope. The grinding room contains two slow running carborundum discs, while the polishing room is equipped with four special polishing machines (by Beck) with adjustable speeds arranged to suit different metals. Special rooms are provided for etching and mounting sections and for visual examination under the best conditions. The photo-micrographic room is provided with isolated foundation blocks to carry the projection apparatus, and hood and flue to carry off the fumes from the arc lamp. The microscope equipment includes three Rosenhain metallurgical microscopes (two for visual work and one for photo-micrography) a set of Zeiss apochromatic objectives and a large Zeiss projection apparatus, with an arc lamp by Leitz.

Two dark rooms are provided for developing photo-micrographs, while a larger room, which can also be darkened, is devoted to photographic printing, enlarging, etc. Other rooms on the ground floor are devoted to special researches, particularly to those dealing with the behaviour of metals in vacuo, special rooms being also provided for the preparation and elutriation of polishing materials and for the storage of specimens connected with the work of the Department. The workshop (formerly the standard lathe house) is to be equipped with testing machines and some machine tools. The foundry provides ample space for handling metal in comparatively large quantities; a 3-ton travelling crane is provided. Gas-heated furnaces by Fletcher Russell and by The Richmond Company, are installed and some fairly large castings have been made.

The second floor of the main block contains the offices of the Superintendent and staff, and rooms devoted to small laboratory furnaces and to pyrometry. The delicate potentiometers are placed in a special room situated between those devoted to gas and electric furnaces. The electric furnace room contains the switchboard, which controls a 450 ampere-hour storage battery situated in an adjoining room.

The chemical laboratories, with the chemical wing of the Wernher Building now include special rooms devoted to the following branches of work:—Steel analysis, alloy analysis, chemical work on cement and on road materials, chemical work connected with aeronautics (two rooms), electro-chemistry, gas analysis and spontaneous combustion research.

The work of the Department was carefully explained by the members of the staff conducting the visitors, the latter expressnig themselves as being greatly pleased with the visit.

British Foundrymen's Association: London Branch Programme.

The programme of the forthcoming session of the London Branch of the British Foundrymen's Association has been arranged, and includes Papers of a very interesting nature. The programme of the meetings is as follows:—

Friday, October 11.—"Education in Relation to the Status of the Foundry," by Alexander Hayes.

Friday, November 8.—Open night, for the discussion of "Melting of Brass and Gunmetal by Gas, Oil and Coke."

Friday, December 13.—Lecture by W. Rosenhain, D.Sc., B.A., etc., National Physical Laboratory, Teddington.

Saturday, December 14.—Annual Dinner of the Branch, Holborn Restaurant, London, W.C.

Friday, January 10, 1913.—"Mechanical Properties of Metals at High Temperatures," by Fred. C. A. Lantsberry, M.Sc., (Birmingham Small Arms Company).

Friday, February 14.—"Pattern-making," by J. W. Worrall (Commercial Cars, Limited), Luton.

Friday, March 14.—Open night, for the discussion of "Foundry Failures."

Saturday, April 12.—"The Application of the Microscope to the Foundry," by George Hailstone (W. & T. Avery, Limited), Birmingham.

British Foundrymen's Association and the Engineering Exhibition, Olympia.

In connection with the Engineering Exhibition which is to be held at Olympia on October 4 to 26, it is interesting to record that through the services of the Council of the London Branch of the British Foundrymen's Association, the Organising Committee of the Exhibition have kindly provided space in the gallery, near the band stand, for a meeting place for members of the Association visiting Olympia. Members will thus have a rallying place, and be able to foregather without inconvenience. Country members visiting the Exhibition are desired to advise the London Branch Secretary, Mr. T. Murphy, Gamage Buildings, Holborn, E.C., who will endeavour to arrange for them to meet other members, and will be able to supply on application tickets at half price to members. Remittances for tickets, with stamped addressed envelope, should be enclosed with application.

Pattern-Making.*

By T. R. Schofield.

If it is granted that real patterns are essential to bring us nearer to the ideal of foundry efficiency, in conjunction with the enormously increased facility with which a pattern can now be made for a correspondingly reduced cost, it is evident there is not now the same justification for adoption of makeshift methods as formerly, and that continued persistence in such methods constitutes a serious bar to legitimate foundry progress.

Modern Developments Affecting Casting Design.

The past ten years have witnessed intensified concentration on the part of engineers, in those spheres which are peculiarly theirs, viz., the efficient utilisation of natural sources of power, and the acceleration of production. Among prime movers we now have, for very high powers, the steam turbine and internal-combustion engines for both gas, oil and spirit, placed upon a commercial basis. Increased efficiency, higher speeds of rotation, and higher range of temperatures, also the cutting-down to a minimum of clearance spaces, have resulted in increased complexity in the castings forming the principal elements of these engines, and have brought into prominence the need for greater precision and uniformity in such castings than has ever obtained hitherto. Leaky joints and much expensive machining and fitting are obviated by combining in a single casting, whenever possible, elements which have hitherto been made separately; these combinations are characteristic of the time, and involve both the foundryman and pattern-maker in greater responsibility for their satisfactory production.

Mr. T. R. Schofield.

In the sphere of rapid production, the scientific study of the principles underlying the best use of metal-cutting tools, and the introduction in recent years of high-speed steel, have completely revolutionised the design of machine tools. All-gear drivers, quick-change gear boxes and other time-saving, production-increasing features incorporated in their design, have transformed the simplest of them into more powerful, more productive, more nearly automatic machines.

Standardised methods of handling castings in quantities for machining, to reduce costs, with the need for interchangeability, have resulted in the application of jigs for all possible purposes, and only serve to emphasise the need which exists for the highest degree of precision in the castings supplied.

It would seem reasonable to deduce from the foregoing remarks, that those concerned in the economical production of castings, in order to fulfil the requirements indicated, embodying great intricacy and precision, have no small part to play in the maintenance of progress. My concern is with the attitude of the pattern-maker to these developments, how, incidentally, the foundry is affected through him, and what can be done to ensure that he shall efficiently discharge his functions as a worthy member of the advanced organisation of the engineering profession.

False Economy in Pattern-Making.

The work of the pattern-maker leaves him with more scope for the exercise of initiative than almost any other branch of engineering; it is under his hand that the work of the designer first finds tangible expression, and he is frequently entrusted with a large measure of discretion and enjoys opportunities for intercourse and suggestion with the designer. The live designer does not despise his suggestions; the tangible expression above mentioned often takes forms which render it almost unrecognisable to the designer, who has to take him somewhat on trust, and in whom are induced feelings of respect (I had almost said, awe) because of the uncertain factors which seem to surround the evolution from drawing to casting.

Many of the qualities which characterise the designer are also found in the successful pattern-maker; both perform certain duties which are but steps toward a final achievement; the actual work of each has no place in the finished product, and for this reason both enjoy the distinction of being called "non-producers." Some enthusiasts have carried the thought further, and styled both as "necessary evils," and I have frequently heard the pattern-makers' fame linked with that of Ishmael; so that their pursuits give them ground both for mutual respect and sympathy.

From time immemorial, money spent on making patterns has been regarded in many quarters as lost beyond recall. Certainly money spent on superfluous or unnecessary work in any department is loss, but the necessity which exists for efficient patterns surely displays the inconsistency of such an attitude. The foundations of true economy must be laid, not upon such prejudice as above mentioned, but by paying the same attention to the equipment of the pattern shop and the methods of producing the patterns as has proved so successful in the productive departments.

A pattern is a tool provided for the moulder's use, but unlike most tools, it is used in a somewhat spasmodic manner. Such patterns as are used more or less continuously, *i.e.*, standard patterns, are worthy to receive every possible attention, regardless of cost,

* Abstract of Paper presented before the Cardiff Convention of the British Foundrymens' Association.

since this is relatively small. Most patterns, however, are not used so frequently, and for this reason the relative cost increases accordingly. In any case, good castings, involving minimum labour in the foundry, and with allowances so fine as to require the minimum time for machining and fitting, demand patterns made to some recognised standard of quality. When the saving in first cost of a pattern is outweighed by the cost of extra labour in the foundry, the pattern ceases to be a cheap one.

The desirable quality of a pattern, then, is measured by the facility with which the mould is produced from it. Its purpose is strictly utilitarian, and superfluous work is to be deprecated. Such a criterion might be applied to some of the ill-considered, rough, or "jerry-built" apologies with which the moulder is painfully familiar, and I think it will be agreed that there is still scope for improvement.

With a reasonable standard of efficiency adopted, the cost need not be prohibitive if proper equipment is provided and up-to-date methods adopted to produce the patterns. In analysing the various operations necessary to make a pattern, it is my intention to show in how many ways mechanical operations can be used instead of hand operations, with an enormous reduction in cost.

Where a broad view of economy in pattern cost is taken, so as to embrace the foundry and subsequent departments handling the work, a higher standard of finish is secured in the castings, production is enhanced, and the foundations laid for realising more fully the great potentialities of the foundry.

Pattern-Making and Equipment.

The work of the pattern-maker might be roughly divided under the following heads:—

(1) Planning or previous study of methods.
(2) Machine work of sawing, planing, turning, etc.
(3) Setting out and building.
(4) Hand-work of paring, carving, filleting, glass-papering.

As previously mentioned, the method decided on from preliminary study of the drawing has more than a passing interest to the foundry concerned, since that department ultimately suffers from errors of decision at this juncture. A thorough study of the drawing by the foreman pattern-maker enables inconsistencies in design to be corrected, and modifications to be made to simplify the work both in pattern-shop and foundry. For instance, the hollow box section, beloved of machine designers, frequently necessitates cores either suspended in the cope, or insecurely balanced on chaplets in the drag, these chaplets often being cast into faces requiring to be machined, thus adding to the troubles of the machine shop. A timely suggestion being made, the designer cannot fail to appreciate the force of the argument, and small but sufficient apertures are provided, ensuring proper support in prints for the core, efficient venting, and satisfactory results. Instances could be quoted where, from a simple suggestion, the whole design has been altered, with a considerable gain in all-round efficiency.

The planning of the pattern must be, above everything, thorough, and embrace all the essentials of the construction and subsequent moulding; the foreman's decisions should be modified, as occasion arises, by consultation with the foundry head, whose advice and co-operation are of prime importance in securing the best results, and in avoiding those vexatious alterations to patterns often made necessary when found unsuitable to foundry conditions.

This preliminary work done, the job can be put in hand, accompanied by explicit instructions; the pattern-maker can proceed in the most direct manner with the work, unhindered by doubts or fads, progressing more rapidly with it than if it were imperfectly thought out and difficulties left to be overcome as they presented themselves, which is not the modern way. It is a mere commonplace to say that economical production is secured in any branch of business by a proper planning beforehand of the work to be done, and possible difficulties as far as possible anticipated and provided for.

In work of a more or less intricate nature, involving the use of many cores, a full-size layout of the job on a board proves most helpful. Machining allowances can thus be shown; troubles in connection with the swelling of baked cores can be to some extent provided against by allowance for this being indicated on the layout, and the energy expended in rubbing cores to fit prints can be reduced if not eliminated.

With the use of a layout, a large job may often be sub-divided to advantage, individuals each handling separate units which together make the complete pattern. By this means, precise methods of execution can be employed, and much economy of time effected.

Machine Work.

The machines provided for the use of pattern-makers are the same general type as usually applied to woodwork, and include machines for sawing, planing, turning and grinding, among others. All of these are a practical necessity where a fair quantity of work is handled. Machines specially adapted to modern shop needs are available and only require intelligent handling to justify their installation.

The modern circular dimension saw is a precision tool; it carries two saws on separate spindles, capable of being operated alternately, by means of a hand-wheel movement. The height of the saw above the table is adjustable from zero to about 4 inches; the fences or work guides for ripping and cross-cutting, and the work table itself, are designed to make the machine as universal in application as possible, each being capable of an angular movement of half a right angle, a few seconds only being required to set up for a job. These features enable straight work to be sawn dead to size and angle, and worked into the job without the necessity of an intermediate handling. For example, a framed core-box is made in a few minutes, with the ends cut off to the correct length with allowance for draft, and checked into the sides. Polygons for hollow cylindrical patterns, and the lags for the same, require very little further attention; in fact, these machines are so valuable that one is led to think that it might be an advantage to have a small edition of them placed at the end of each bench, ready for the thousand and one jobs on which it is prepared to demonstrate its efficiency.

Two jobs of rather an unusual nature may be worth mention here, as showing the term "circular saw" to have in this connection a meaning deeper than the conventional one. The first is the roughing out of a semi-circular half core-box (see Fig. 1) or similar work. The rip or coarse-tooth saw is set so that its highest point is above the table at a distance equal to the radius; the ripping fence is then swung out of its normal position, which is parallel to the plane of saw; the angle which it makes is determined by measuring from the extreme points of the saw blade at table level perpendicular to the fence; the fence is correctly set when the difference between these measurements equals the diameter of box, or double the height of saw above the table. (The pattern-maker with mathematical tendencies might calculate the angle as follows:—let D = diameter of saw, d = diameter of box; then $\frac{1}{\sqrt{D/d}}$ gives the sine of required angle when the actual values are substituted.)

The setting accomplished, the saw is lowered, and the interior of box cut out by a series of successive cuts, the saw being raised about ¼ in. each time. The final cut is not quite circular, but very little labour suffices to make it so.

The second job for the saw is the cutting of the thread on the pattern for a worm (see Fig. 2). The conventional method is to wrap a paper templet round the worm blank, on which is drawn the straight line development of the thread; then follows the relieving out of the thread, about as tedious a job as we have to handle. By this method the pattern comes out very expensive and not very accurate.

This job can be done on the circular saw without any setting out, and with variation of pitch not exceeding one-hundredth part of an inch. The shallow-toothed cross-cut saw is set above the table an amount equal to depth of thread. The turned blank is supported against the cross-cutting fence, whose normal position is perpendicular to the plane of saw, and slides in a groove parallel to the saw; this fence is now turned through an angle equal to the angle of advance of thread (tangent of this angle equals $\frac{\text{pitch}}{\text{circumference}}$). Some adjustment has to be made, and the blank is made 3 in. longer to allow of one or two trial cuts before going through.

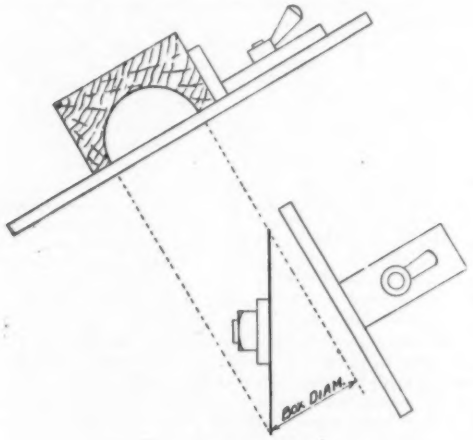


FIG. 1.

The blank, held by the left hand against the fence, is pushed forward with the right until directly over the centre of saw, when the saw will have penetrated the full depth of thread; endwise movement of the blank is prevented by the saw blade. If the fence were square to the saw and the blank twisted round by the hand, a groove would be cut all round. The fence being inclined, however, the blank is rotated with the left hand, and feeds endwise, a spiral cut of the required uniform pitch resulting. Two such cuts are necessary, one for each side of thread. Some hand labour is still required to give the taper side to thread, but it is putting it moderately to say that the total time is reduced to one-half, probably one-third, by this operation which itself takes under half-an-hour.

The planing machine is so familiar as to need little comment. We rarely find means provided by which timber may be planed to parallel thickness; where jointer and thicknesser are provided, either separately or combined as one machine, hand work of this kind is almost eliminated. If due care is taken of the cutters, many jobs such as wheel rims and other circular members may be built up with good joints, without any hand planing whatever, a matter which is worth considering as one of the many economies that can be effected.

To sandpaper one's work to shape was anathema to the preceding generation of pattern-makers; we are now, without shame, grinding to shape a big percentage of our work, large and small, on the sanding disc, with results satisfactory to all concerned. The saving in cost is enormous, and its use enables many novel modes of construction to be applied, which, with the invaluable aid of leather fillets, secure the desired form and finish in a much more direct manner than is possible with hand labour. No pattern shop is complete without the sanding disc; it would be impossible to enumerate in how many ways it is advantageous, for it embraces in its scope nearly every detail of a pattern. That it is not a toy may be gathered from the fact that wheels of all sizes, up to a foot wide, are ground to shape, with correct draft, from the rough, with a speed which puts the lathe to shame. The lathe has been put partly out of commission with the advent of the sander, but has been compensated in our case by a suitably large face-plate and tilting table attachment for the lathe, thus combining in one machine the functions of both, and forming an inexpensive and efficient arrangement.

One might also mention in passing that lathes with wooden beds are not ideal for doing good work. Cases have been known where work a little too large has been accommodated by relieving a little out of the

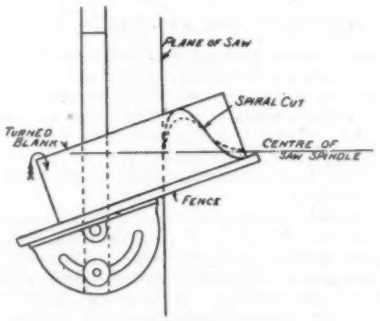


FIG. 2.

lathe bed; such a practice pursued for long can only end in disaster. Even where iron beds are provided, one looks in vain for the slide rest, which is as invaluable for turning wood as for most other materials, where precision and time are of importance. One can only wonder, and hope for the best.

Setting Out.

It has always seemed to me, since a casting cannot be more accurate than its pattern, that the pattern deserves every care devoted to ensure that faces shall be truly perpendicular, and shaft centres bear their proper relation to each other and to the faces. To ensure this, the setting-out table of the fitting shop, with accessories in the form of angle-plate and scribing-block of adequate size, are an absolute necessity in the pattern-shop. Where these facilities are provided, the work of building up the pattern, whether it be a wheel rim or a machine or engine bed, is greatly expedited; machining allowances can be cut down to a minimum, and, in short, all the advantages realised of using precise, in place of rule-of-thumb methods.

In the foregoing remarks, I have tried to show that foundry efficiency demands a high standard of quality and completeness in the pattern. Also that patterns

capable of meeting this demand satisfactorily, while ensuring castings on which a minimum of labour is necessary to machine and assemble, need not be prohibitive in cost, if methods are studied and equipment adapted to suit present needs.

Tube with Internal Conveyor Scroll.

The interest of the pattern-maker in his work is never more keen than when engaged on work of a somewhat unusual character, and possibly no class of work is more interesting or so puzzling to the outside observer, as that in which are used assemblages

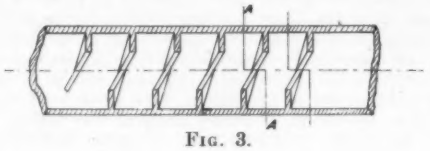


FIG. 3.

of cores. The tube illustrated in Fig. 3 is of this kind; it was required to be of cast iron, $\frac{1}{2}$ in. thick throughout, $8\frac{1}{2}$ in. outside diameter, 53 in. long. The clear bore was $3\frac{3}{4}$ in. diameter, so that the thread was $1\frac{1}{8}$ in. deep, the pitch being $3\frac{3}{4}$ in. Only a few castings were wanted, and a core-box the full length would have been not only expensive but a mass of loose pieces, difficult to locate in the box, without any advantage to the core-maker. The method adopted was cheap in pattern making, and provided the foundry with a number of compact cores, quickly

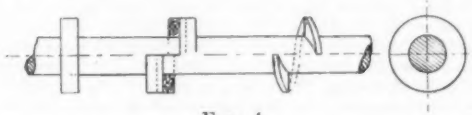


FIG. 4.

made and readily assembled to form the completed core.

The castings did great credit to the foundry, and were uniform, smooth and without chaplets, a necessary feature as the tubes were subjected to great heat. The pattern was simply a plain cylindrical one, with prints at each end to carry the core. The core-box contained one complete thread, and 10 cores out for the complete core. The first and tenth cores differed from the rest, which were all alike.

The joint between the cores required attention, as a plain face would give feather edges and be unworkable; for that reason the face was formed with a

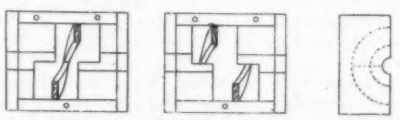


FIG. 5.

step equal to half the pitch (see A A, Fig. 3) which overcame this difficulty, and had the additional advantage of one position only in assembling, and imparting stiffness to the finished core.

The box is shown in Fig. 5; the holes in the ends received a $1\frac{1}{2}$-in. print, the diameter of the barrel on which the core was built. The thread was made in four pieces; four equal segments were built on a parallel block turned to $3\frac{3}{4}$ in. diameter forming a circular flange 2 in. thick. This was turned to fit the box ($7\frac{1}{2}$ in. diameter). Three of these pieces were then moved along, each $\frac{7}{8}$ in. (one quarter the pitch) in advance; two parallel helical lines were then set out, $\frac{1}{2}$ in. apart, and the faces of the thread pared out by hand, these faces being square with the turned block at all points. The true form of thread was thus secured. Before removing from the block the positions of the thread sections were scribed in the box, making their ultimate location and securing an easy matter. Blocks at each end of the box gave the staggered face to the core; for the end cores these blocks were removed alternately and pieces inserted to give the required forms. The cores were, of course, made in halves and glued together, being afterwards built on a barrel, and finished off, a very satisfactory core being obtained.

A Quickly-Made Half-Wheel Pattern.

The advantages of modern methods are best appreciated in the case of the "hurry up" job. The wheel shown in Fig. 6 is a case in point. It was 40 in.

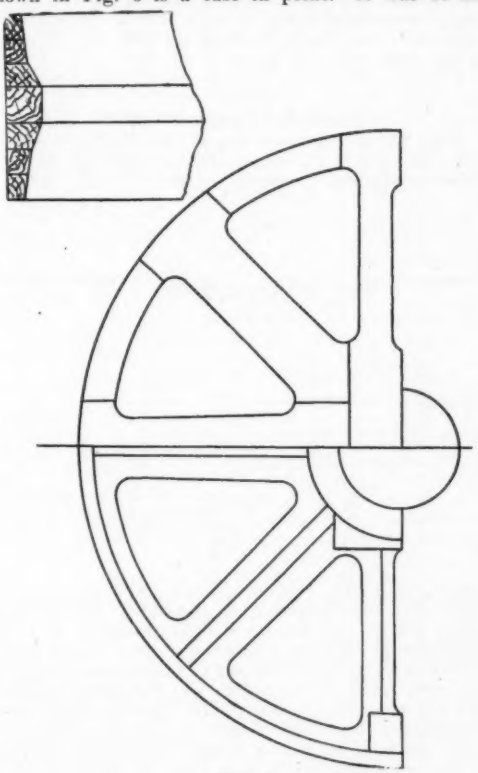


FIG. 6.

diameter and had 72 teeth $1\frac{3}{4}$ in. pitch, which had to be relieved to ensure soundness; and width of the face was 12 in. The teeth, though only rough approximations in form, had, of course, to be correctly spaced. The pattern had central arms, ribbed up to the rim, bosses 12 in. diameter for four bolts, and bolt lugs at rim. It occupied in making, 10 hours by three men.

First, a part plan and section were laid out full size on a board, and all possible information shown to expedite work; machining and draft allowances were shown, also thicknesses of timber, and, as far as practicable, other details of construction of the pattern. This preliminary work enabled the job to be efficiently subdivided, and the work on each detail to be proceeded with directly, and completed before assembling.

No hand planing was done whatever, except circular planing of the inside of rim segments after these were band-sawn to the line and bevel. The central plate arms were first assembled, the parts being adequately secured with corrugated fasteners, which are indispensable in the pattern-shop. The rim segments were then built on this, attention being devoted only to the inside, to eliminate subsequent dressing off as far as possible. When the rim was built the sander table was set to give one-tenth inch taper, and the outside of rim ground down to size, making a first-rate job. The working in of the bosses and ribs proceeded while the teeth were being spaced out and attached. The assembling of the parts completed, and very little more sufficed to hand over to the foundry an accurate, serviceable pattern. The method of previously planning the job, and proper facilities, cause a single cut at every point to suffice, instead of a roughing out, "somewhere near," with a more or less generous allowance for finally working to size. In this way much time is saved.

Trough for Large Automatic.

Most patterns are successfully handled by first constructing a stiff foundation forming part of the job; this foundation is usually either a solid block, a

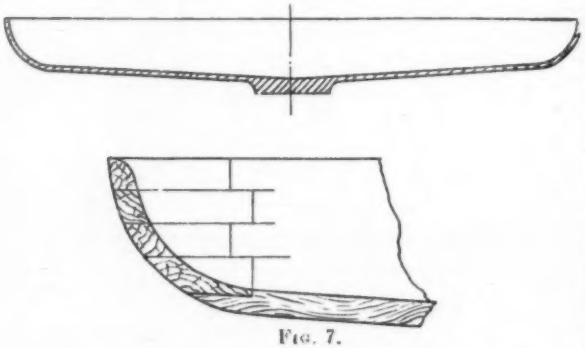


Fig. 7.

frame, or a box, sufficiently stiff to be relied upon while the superstructure is proceeded with. Many others are of such form and light character as to be incapable of standing alone until near completion; cases are on record where even the final coat of paint has been relied on to impart the necessary stiffness, and are somewhat analogous to the villa which is so scientifically built as to rely on every element of paint, lathe, plaster, and internal paper for stability. A more desirable analogy is that of the arch, only supported until the keystone is inserted, and then capable of displaying stability for all time.

The trough illustrated in Fig. 7 was of the kind needing to be supported until practically complete; its keel was laid on the shop setting-out table, and there it remained until fit to be moved; its dimensions were roughly 6 ft. by 3 ft., metal ½ in. thick, with 1½-in. fall to the centre for drainage. The large-radius sides and corners, and the hopper form of base, made it a more difficult job than might appear. Details of construction were taken care of by previous layout and planning as far as practicable. The base was first built of four triangular frames, half-lapped together on the saw; the vertices converged at the centre, and rested on the table, the outer edges being raised on 1½-in. parallel packings; this gave the right hopper form to the base. The 6-in. radius mould was got out in four straight lengths, and one full circle turned for the corners, which were cut out with a fine saw, giving the four quadrants. These elements were, after finishing the inside faces, united as shown, similar to brickwork bonding; this was facilitated by all timber being machine-planed to one thickness. Rebates were cut round the base to receive the moulds and provide the necessary thick edge to the radius. Seatings for headstocks, bosses, facings, etc., are not shown, but were accurately placed with the aid of an ample scribing block working off the table face. The castings required were made without need of an iron pattern, and the pattern continues to justify the care spent on its construction, survives storage without shrinking or warping, and costs little for repairs.

It has been my aim to show that it is better to seek for economy by attention to details and methods, rather than by sacrificing the quality of the patterns to a false sense of economy. If I have been wearisome, or tended to overstate some of the trifles that seem to me to demand attention in the interests of progress, I hope I may be excused on the ground that in attention to trifles lies our hope of perfection.

Discussion.

Mr. F. J. Cook, in opening the discussion, said there were one or two points which he was glad to find had been duly emphasised. One was the necessity of the education of the designer to a better appreciation of foundry difficulties and possibilities. That was a very desirable thing. As he had previously pointed out, this appreciation was rather lacking among designers in this country, and the need of it could not be emphasised too much. The author had also shown the necessity of good equipment in the pattern-shop. On the Continent, and also in America, there was a remarkable superiority in the equipment of the pattern-shops over what one generally found in England. The author had also given them a great many "kinks" which would be useful to the practical man. Mr. Schofield had also emphasised the importance of close relations between the pattern-maker and the drawing office, and he (Mr. Cook) quite agreed with that, but he would like to carry it further; he thought the relationship of the pattern-maker should be very close also with the foundry. Seeing that the pattern, as Mr. Schofield rightly said, was a tool for the founder, the founder who had to use this tool should have something to say about the way in which it was made. To get the best result from the work of all, the founder should be taken into account, for he was quite as important as the draughtsman and the pattern-maker in obtaining the most economical and satisfactory results.

Mr. Smalley asked the author to give the thickness of the saw in Fig. 1, taking the full width of the saw at the top.

Mr. Buchanan remarked that the Paper was eminently useful, and one which it was desirable to bring before the Association. The author had referred to patterns which were made too complicated from the foundry point of view, in order that matters might be made simpler afterwards for the engineering works. He (Mr. Buchanan) was afraid that patterns which were made for the outside ironfounder to cast were apt to be of more complicated design than those the engineer made to be cast in his own foundry. (Laughter). Sometimes, again, an engineer, in order to cut his own costs, ran up those of the ironfounder 150 per cent., making a very difficult job in the foundry of what would be a very simple job if fitted together in the engineering shop. They were not allowed to discuss money matters in the Association, but he thought that if the ironfounders were in a position to do so—and he hoped they were—they should

try to bring home to the engineer that it did not pay for him to simplify his operations at home by making the work more difficult for the foundryman who had to do the work for him. The engineer who sent his castings out to be made should also try to make them as simple as possible. There was an enormous field for economy in the simplification of parts to be cast by the ironfounder, and the designer, especially, should balance up what was really going to be the ultimate economical result. He should be taught that saving threepence in the engineering shop by spending sixpence in the foundry was not an economical policy. No man possessed all the knowledge and all the skill in that business, but the foundryman did know best what the foundry could do, and in decency he ought to be referred to. They ought to go even further than to the designer; to the man who controlled the designer, so that he might see that the designer did confer with the people who knew what was the best system of doing work in the foundry. (Applause.)

A member, with regard to the remarks on the Paper on the swelling of baked cores, asked the author whether he could lay down any rule with regard to the allowance to be made for this. On one occasion when they were busy at the speaker's works, and had to send out patterns for casting outside, they made the cores from the core boxes. These cores were sent out, but the castings proved to be only about half the thickness required. They had found it a very good practice to make the allowance in core boxes the thickness of a standard rule. He was referring to cores 5 ft., 7 ft., and 11 ft. long.

Mr. F. Penlington (Manchester) said that they knew that it was to the pattern-maker they had to look in a great measure for the success of the foundry. With regard to handling design, the pattern-maker was to a large extent a sort of buffer between the designer and the foundryman. He found various rounds and hollows which were intended to make the casting look nice, but which gave considerable difficulty to the foundryman, and were of no practical use in the finished article. If they could get hold of the pattern-maker and he, in turn, could get hold of the designer, they would be beginning to bind together the three essential personages for the benefit of the whole. Some firms would spend less on a pattern that had to go to an outside foundry than they would if the casting was to be made in their own foundry. The sole rule seemed to be to save as much expense as they could in their own shop. As a rule, castings in outside foundries were made at so much per cwt., and those who sent the work out did not care to what expense and trouble the moulder was put so long as they got the castings cheap. At the present time there were a large number of firms which were offering to make castings at so much per cwt. and provide their own patterns. There was an object in this for, as a rule, these firms took the coarser and heavier and less complicated class of work, and they provided the patterns for nothing because they reckoned to recoup themselves in the extra weight of castings to be charged for. If the pattern-maker as such made any profit and it paid him to make the pattern properly, they would get stronger patterns, stronger castings, better designs, and better results in the engineering trade generally. They must insist upon the designer consulting the foundryman. The designer did not always know the various strains and stresses and other matters which had to be considered in making a casting and which were known to the foundryman. He knew that certain firms were now refusing to make castings from patterns which from the foundryman's point of view were not properly designed, and he believed that in the very near future they would have to insist upon this and refuse to make the castings unless the patterns were satisfactory.

Mr. G. M. Mather (Kent) said that those foundrymen who lived in the country had all sorts and conditions of patterns to work with. Once a countryman who drove a traction-engine and did steam ploughing came to the speaker and said that he wanted to alter the cylinder upon his engine. He said to the man: "What about your pattern?" "Oh," the man said, "I can make it." He said: "Give me your instructions; tell me how you want it made, and the core boxes, and so on." From his knowledge of foundry work he gave the man instructions, and, sure enough, the man made the pattern and also his core boxes. He would not say that he had not some difficulty in moulding the pattern; but the cylinder was cast. The man bored it out, faced his valve, and put the cylinder on, and declared to the speaker that it worked the engine better than the one that had been made by the firm which supplied the engine. Of course, it might be taken for granted that the man thought a great deal more of himself than he did of the firm, but the cylinder certainly worked. That might be taken as an example of what they had to contend with in the country.

Mr. Schofield, replying, said that no doubt it was very important to have the design as simple as possible. In the Paper he had mentioned that there were many reasons why the designs were not so simple as the foundryman would like. One reason was, in connection with such things as cylinders, that gas-tightness was more likely to be secured by having the casting all in one piece. In machine work generally, the designer was actuated by kindred motives. Take, for instance, grinders, which, on account of the combination of troughs with bodies and so on, were possibly the most difficult machines a foundryman had to cast. The object, however, of designing grinders, polishing lathes, and the like in one piece, was to avoid machining, and also to secure rigidity. These were the kind of reasons, as far as he was able to discover them, which were given for the complexity of design which was so fashionable at the present day. But this did bring into prominence the necessity of co-operation between the pattern-maker and the founder; and still more, sympathy between the drawing-office and the foundry. One found very frequently that the pattern-maker's knowledge of moulding processes was vague. But "vague" would not describe the foundry knowledge possessed by some draughtsmen; it was often weird in the extreme, and he had not always found them as ready to receive suggestions as they might be. Some of them seemed to think they were blessed with a certain superiority, and that to accept suggestions would be somewhat lowering to their dignity. It would certainly be a great advantage to bring the draughtsmen into the British Foundrymen's Association. In the shop where he was employed he had been given the privilege of making suggestions to the designer in the sure knowledge that his suggestions would be taken into account. The draughtsmen had not the option of saying that the pattern must be made strictly according to the drawing; they understood that the pattern-maker must be taken seriously, so that he might not be made responsible for things over which he had no control. His opinion was taken particularly with regard to loose pieces. These were not always to the advantage either of the pattern-maker or of the moulder, and he had often had the misfortune to have castings which were wasted through the displacement of loose pieces. With a judicious study of the drawing, very frequently a core could be taken inside which would give uniform thicknesses of metal and enable one to box up on the

outside without disturbing the design to any serious extent, and would secure a very strong and neat casting. With a pattern which had been designed from the foundryman's point of view, and for which he was responsible, there would be little fear of trouble through the displacement of loose pieces. He had not come there to teach them pattern-making; his only purpose was to show in what way more modern methods and appliances could help the pattern-maker, and to point out that if they could make things more quickly they could afford to make a thorough job of them. He had not yet met a moulder who had complained of patterns being too well made, but he had met many who had complained that the patterns were scamped. He had thought it part of his duty to show that there was not the same excuse for scamped work now as there was when the pattern took a much longer time due to the absence of modern appliances; and that if modern facilities for pattern-making were more widely utilised the foundryman would be able to devote himself entirely to getting a sound casting, free from blowholes and blemishes, of ample strength, and so on, and would not have to worry about the fitness of the pattern. The reason why he mentioned the screw was that it was a great practical problem. Many of their difficulties were concerned with screw or helical designs. The width of the saw, as to which a question had been asked, was about 0.15 in. With regard to the swelling of cores, he had not acquired any particular knowledge; he generally did make certain allowances, and these, of course, were in the length and width, and not in the depth. The swelling, he took it, was largely due to the expansion of the irons, and was also partly due to the core-boxes. Probably the springing of core-boxes, rather than the expansion due to the heat, accounted for a great many cores having to be rubbed. He did not think that he would be inclined to allow so much as one-tenth of an inch per foot in a long job; in his case in. had proved satisfactory. But they had not a foundry of their own, and so did not get the benefit of the foundryman's experience in these matters. He was very much impressed by the story of the man who made the cylinder pattern: the man himself may have been an old-time millwright in disguise. (Laughter.) He had heard of a man who had made some very smart patterns of various kinds out of telegraph poles. (Laughter.) Whilst rendering all honour to the old-time millwright, who had left them some very fine examples of his work, they must remember that the pattern-maker, unfortunately, perhaps, for the foundryman, was nowadays a specialist. The old-time millwright undoubtedly made a very good pattern, but he thought that a comparison of his time sheet for a given pattern with that of a modern pattern-maker would be all in favour of the specialist. (Hear, hear.)

Effect of Temperature on Tensile Tests of Copper and its Alloys.

Professor A. K. Huntington, Assoc.R.S.M., in a Paper presented last month before the Institute of Metals, summarises in 32 curves results obtained at various times during the last twelve years. The range of temperatures given is restricted to such as might occur during the use of these metals and alloys in the Arts, as distinguished from the temperatures at which they are worked. The method by which the data were arrived at is also described in detail. Very pure electrolytic copper is taken as a standard for comparison, and first of all various copper alloys are contrasted with it. Broadly speaking, the alloys are found to have the same characteristics as the pure copper. Contrary to what might have been expected, copper is the dominating partner. It has a distinct individuality which is modified, but not extinguished by the other metals. The curves for wrought iron and steel are compared with those for copper, and it is shown that the former are markedly different from the latter. As a result of having to consider generally only cold tests of iron and steel, engineers are in the habit of reckoning the elastic limit as 50 per cent. of the breaking load. The curves given in this Paper show that this method of estimating the elastic limit is not correct for iron and steel at temperatures above the normal, nor, as a rule, for other metals at any temperature. It is fairly certain that engineers have hitherto expected a reduction of elongation with an increase in the breaking load in a given metal or alloy. They have been justified in this by the behaviour of iron and steel at atmospheric temperatures, and they are still justified at such temperatures as these metals are used under in the Arts. That they are not justified in applying this rule to copper and its alloys is manifest from an examination of the curves in this Paper.

Effect of Temperature on Ductility of Zinc.

In the Proceedings of the Royal Society, W. B. Haines states that commercial zinc, which always contains lead, becomes soft at about 150 deg., while it is said to become hard and brittle at about 200 deg. An investigation of these changes was made by measuring the extension of a zinc wire immersed in an oil bath and stretched by a weight applied to the upper end by means of a pulley. It was found that consistent results could be obtained only if the wires had been treated in exactly the same manner. At each temperature the rate of extension of the wire was calculated from observations for several loads ranging up to the breaking stress. As a measure of ductility, the slope of the final portion of the curve corresponding to the particular temperature was taken. Commercial zinc becomes gradually softer with rise in temperature until about 90 deg., when a hardening sets in, which is so rapid that, at 110 deg. the behaviour is comparable with that at 30 deg. From 110 deg. onwards there is a regular softening as the temperature rises; this certainly continues up to 200 deg., and the experiments indicate that it continues at least up to 250 deg. The hardening in the region of 100 deg. takes some time to develop. The effect of heating zinc wire to temperatures above 120 deg., and then cooling, is to diminish greatly its tenacity and ductility; this is due to the crystalline structure induced. The ductility is restored by some such mechanical process as hammering; this destroys the crystalline structure. Comparative experiments were made with bars of pure zinc and of commercial zinc (which contained 0.52 per cent. lead). The pure zinc shows no anomaly at about 100 deg.; it becomes uniformly softer as the temperature rises, the only peculiarity being a hardening around 200 deg. Hence the evidence leads to the conclusion that the singularity observed in the ductility of zinc at temperatures around 100 deg. is produced by the admixture of a small proportion of lead.

Making Double Flanged Pulleys from Standard Pulley Patterns.

I.—Pulleys with External Flanges.

By Francis W. Shaw.

Make-shift methods very seldom pay, but the method to be described, of making double-flanged pulleys, was a make-shift method hardly to be bettered by the preparation of special patterns and tackle, unless one excepts moulding machine methods, which were in this case not available.

Method of Moulding Ordinary Pulleys.

The practice of the firm—a firm of jobbing iron-founders in Yorkshire—was as follows:—They had

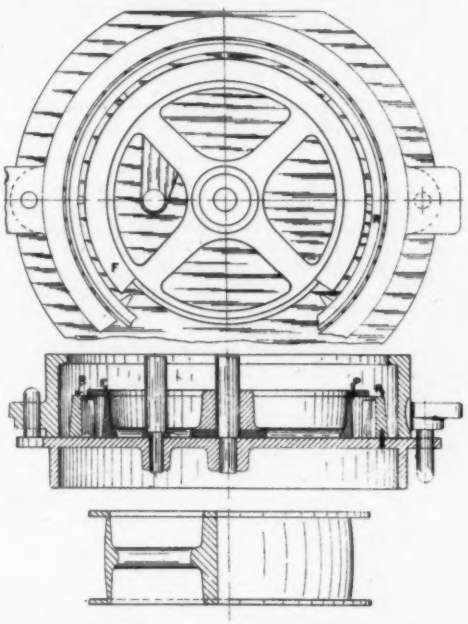


Fig. 1.—Method for Ordinary Pulleys.

a very comprehensive set of standard pulley patterns, and the method that had been adopted may be explained by a reference to the illustrations, which, however, have been prepared specially to illustrate the moulding of the double-flanged pulleys. Only half a pattern was used, and this was mounted on a circular jointing plate in the manner depicted at Fig. 1 (the flange, of course, being absent). Two box parts were rammed up from the one half pattern, one having the usual runner and risers, the other without. To permit these two box parts to be assembled, each had one pin and one hole as shown. The pattern itself was carefully made and fixed to the jointing plate to ensure an exact matching of the halves. The runner stick was turned from a piece of round bar and fitted into the jointing plate, holding in position the special gate former, which was very thin at the end in order that it might be readily broken off at the arm in the casting. The print for the central core was also made from a piece of round bar and fitted into the jointing plate. Several sizes of these were used for different diameters of cores. The boss was of wood, and this was also a variable piece. The pin and hole in the jointing plate were of course, carefully located in respect to the pattern, to ensure matching of the two parts of the mould. The box parts were machined at the joints and the jointing plate was also machined on the top face.

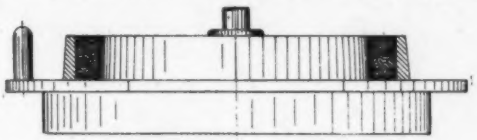


Fig. 2.—Core-Ring on Jointing Plate.

In moulding, first the drag was rammed up, the runner stick and gate being absent. The whole was rolled over, the jointing plate rapped and then lifted, drawing with it the pattern, but leaving in the mould the loose boss and the print. The same procedure was followed in the case of the cope, except that the runner stick and gate were placed in position in the jointing plate prior to ramming up. It will be noticed that the rim of the pulley pattern is tapered so that the rim of the casting approximates as clearly as possible to the crowned form.

Making Double-Flanged Pulleys from the same Pattern.

Flanged pulley castings are not as a rule crowned. It is usual to mould them in a three-part box, the

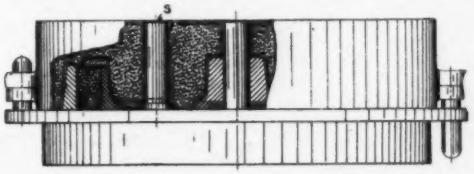


Fig. 3.—Loose Flange and Box Part in Position.

portion between the flanges being taken in the middle part; hence a pattern tapered on the rim would be an embarrassment. However, it is quite as necessary to crown flanged pulleys as to crown plain ones. Unless this be done, there is a great tendency for the belt to climb the flanges, and in any case severe rubbing would take place. Flanges are intended to retain the belt in cases where the side space is limited and where the belt, if it came off, would jam between the pulley and some part of the machine frame. They retain the belt, too, when there is a sudden accession of resistance. Beyond this there is no virtue in flanges, but the crown is

an absolute necessity, allowing for errors in alignment. Hence it is better to crown flanged pulleys; and if they are to be crowned, machining is saved, and not a little metal, by tapering the patterns; if the modern method of grinding pulleys from the black is adopted, there is considerable gain in grinding time.

Referring to Fig. 1, the only addition to the outfit for standard pulleys was the flange, F, retained in concentric position by three small pins P, and the core ring R, dowelled to the jointing plate. Inward projecting ribs retained the sand.

The Moulding.

The procedure in moulding was as follows :—First, the core ring was placed in position on the jointing plate (as shown in Fig. 2), the sand rammed up and

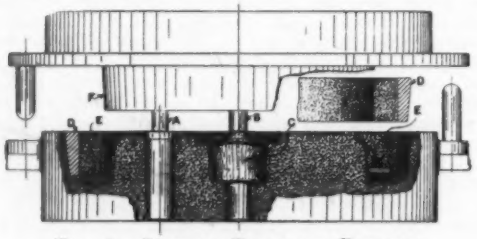


FIG. 4.—JOINTING PLATE AND PATTERN LIFTED.

struck off level with the top edge of the rim. Now the loose flange was placed in position; then a box part, and rammed, as shown in Fig. 3. The runner stick S was omitted for this part. The whole was rolled over and the jointing plate lifted with the pattern F, as shown in Fig. 4, leaving in the mould the parts A, B, C, D, and E. The core ring D, with the green-sand core already rammed in it was now removed, holes (not shown) in the top edge being provided for lifting. This allowed the removal of the loose flange E, shown partially raised at the right-hand side of the illustration. Note that the right-hand side shows both core ring and flange removed; at the left-hand side both are still in position. The removal of parts B and C completed the drag part, so far as Fig. 4 is concerned. The procedure in respect of the cope was similar, but in this case the runner stick was inserted in the jointing plate. Fig. 5 shows the remainder of the procedure. The core ring appertaining to the drag was replaced as shown, then upon it the core ring appertaining to the cope, the latter being set so that the outer edges were in complete agreement, as shown at the left-hand side of the illustration. Note that these rings were turned on their periphery and were fixed exactly concentric with the pulley pattern on the jointing plate by means of dowels. The cope after the usual finishing—trimming up, making risers, etc. (not shown)—was lowered into position. Its position during this operation is shown at the left-hand side of the illustration; at the end of the operation, at the right-hand side, which shows the mould finished and closed up.

Chilling the Holes.

A word or two with respect to the holes in the bosses. To ensure a sound casting, chills were used. These were made from steel bar and were slightly

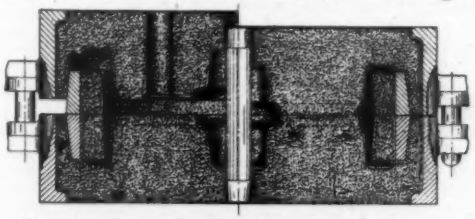


FIG. 5.—COMPLETION OF MOULDING OPERATION (LEFT HAND) AND CLOSED MOULD RIGHT HAND).

taper to facilitate removal from the casting. The chill was fixed (of course prior to closing up) as nearly vertically as possible. As the cope was lowered, the taper end ensured the chill taking up a vertical position as it encountered the hole in the cope. The chill was given a coating of paste plumbago to prevent scaling.

Runners and Risers.

The runner and riser heads were formed in bushes and applied to the top of the mould after closing up. The use of bushes for this purpose saves useless ramming and extra weight to be lifted in the mould parts themselves, as these would need to be much deeper to get the necessary "head."

This method of moulding is, of course, applicable to many other castings having external flanges or projections, often saving the extra jointing entailed by a three-part flask.

The Testing of Moulding Sands.*

By Alfred B. Searle (Sheffield).†

Whenever a material is used which occurs in a natural state, it is usually subject to variations in character which may utterly spoil it for the purposes for which it is employed. The sands used by moulders ought, therefore, to be tested in some way in order to minimise the losses which would otherwise result from the use of unsuitable sand. The necessity for some form of testing is recognised in an indefinite manner by every moulder, and some of the "tests" applied in the shops are of value, though very crude and limited in scope. On the other hand, moulders have generally failed to recognise the necessity for more complete knowledge of the sands they use, and many of them are, in consequence, paying more dearly for their sands than would be the case if they were tested properly. One particularly striking example occurred recently in the experience of the writer, in which a firm were purchasing sand from 140 miles distance when a sand more suitable for their purpose, but of less attractive appearance, could be obtained from a pit close to the works. In this instance a certain amount of prejudice existed, for the foreman moulder was accustomed to a particular sand and did not see fit to change when he entered the employment of another firm. It was only when the characteristics of the two sands had

* Presented before the Cardiff Convention of the British Foundrymens Association.

† Author of "British Clays and Sands," etc.

been closely compared that their practical identity was proved and they were used with success on a commercial scale.

The lack of information on the subject of testing makes it difficult to lay down a complete series of tests, for the requirements of different shops differ very greatly and the idiosyncrasies of different moulders must also be considered. For instance, in one shop in which the writer is interested, three different moulders used three different sands, and could not, for a long time, be persuaded to change. Even that most cruel test of all—the secret substitution of one sand for another—failed to overcome the difficulty as soon as the substitution was discovered, though during the three months it remained unknown no noteworthy troubles occurred.

The chief measurable characteristics of moulding sands are (*a*) refractoriness, (*b*) porosity, (*c*) permeability, (*d*) fineness, and (*e*) strength when formed into a mould. It will be observed that these are all physical properties, yet they are, to some extent, de-

Mr. Alfred B. Searle.

pendent upon the chemical composition of the sand, and this must therefore be taken into consideration.

Chemical Composition.

To a large extent this has been misunderstood, and analyses of sands have therefore been made on lines which are not to the best interests of the moulder. For example, the composition of a typical moulding sand will usually be reported as follows :—

	Per cent.
Silica	84.13
Alumina	9.42
Iron oxide	4.41
Lime	1.73
Alkalies	0.31
Total	100.00

In the first place it will be observed that the analysis adds up to precisely 100.00, a feat of skill almost impossible even to the ablest analyst and an almost certain sign that some constituent has been "estimated by difference." This is a convenient way of stating that the analyst has been too lazy, too busy, or too ill-paid to make a proper analysis, and has determined the silica, alumina, iron oxide and lime, and has then found that 0.31 per cent. of material remains unaccounted for. He therefore describes this "difference" as "alkalies," and soothes his conscience with the thought that so small a percentage of any ingredient can make no appreciable difference in the value of the sand. This method of working is all the more usual because the labour attending an actual determination of the alkalies is equal to that required for all the other constituents put together.

For some purposes, such as glass-making, an accurate knowledge of the proportion of alkalies is unimportant providing that the sand is otherwise pure; but for moulding, the presence of lime, magnesia, and alkalies—even in small quantities—has a notable effect on the heat-resistance of the sand, and their proportions should be ascertained with great exactitude. It is, as a matter of fact, less important to know the proportion of silica than of alkalies, and if so complete an analysis cannot be obtained on account of the cost or labour involved, it is better to treat the sample with hydrofluoric acid until all the silica has been driven off and to analyse the residue, than it is to make a guess at the proportion of alkalies, as is so frequently done.

A further serious defect of the ordinary method of reporting the results of an analysis in the form given above is that it does not give the information required by moulders.

Sands are essentially composed of three groups of substances, (*a*) quartz, (*b*) clay, and (*c*) other minerals. Of these the quartz is the main constituent, its grains being bound together by the clay; the "other minerals" may be regarded as impurities. The quartz (if pure) is composed entirely of silica, but all the silica in a sand is not in this form. Some of it occurs in combination with alumina in the form of clay and the remainder in combination with lime, magnesia, iron, and "alkalies" forming "other minerals," the nature of which must be determined (if necessary) by a careful microscopical examination.

Many attempts have been made to resolve sands into their constituents, quartz, clay and other minerals, but no chemical method yet devised has proved satisfactory. Bischof and Seger, some 30 years ago, devised what is known as a "method of rational analysis," in which the material is treated with boiling sulphuric acid and then with caustic soda. These investigators thought that the clay alone would be dissolved by this treatment, but it has since been proved conclusively that the method is quite unreliable except for relatively pure china clay—a material of little or no interest to moulders.

If "rational analysis" gave correct results these would agree with the results of an ordinary or ultimate analysis which is known to be obtained by correct methods. In actual practice, however, the two results differ so largely that it is very unwise to place any reliance on the results of rational analysis.

In a Paper by Mr. J. Shaw in the April, 1910, issue of the Foundry Trade Journal, both ultimate and "rational" analyses of a number of sands are given, though the former are far from complete. In none of the analyses given by Mr. Shaw do the results of the two methods tally, and a careful comparison will show such serious discrepancies in the "rational analyses" as to necessitate their being abandoned.

Some idea of the mineralogical composition of a sand may be gained by assuming that the alkalies, lime and magnesia, are all in the form of felspar, and then calculating the proportion of alumina and silica corresponding to this assumed felspar. Any

excess of alumina may then be calculated to "clay" (Al_2O_3. 2 SiO_2. 2 H_2O), the silica corresponding to this deducted from the silica not in the form of felspar, and the remaining silica may then be assumed to be quartz. This method—due to Fresenius—gives results which are no less accurate than the "rational analysis," but they are subject to the serious objection that felspars do not contain magnesia and that in some sands the bases are present as mica and other minerals. Hence the only method which is at all reliable consists in a careful microscopical examination of the sand and in deducing from this the proportion of the different minerals present. Needless to say, this is a very ardous task and one beyond the skill of any but an expert.

Quartz.

The basis and chief constituent of sand is one of several forms of silica. It is seldom pure in moulding sands and the presence of iron oxide, lime and other substances materially detracts from its value. Broadly speaking, the more pure quartz a moulding sand contains the higher will be its value.

Other Minerals.

"Other minerals" is a large term, and includes the small grains of almost every kind of rock, but particularly of rocks of igneous origin. In moulding sands it is extremely difficult to identify the various minerals present and this identification is, in consequence, seldom attempted.

There is, unfortunately, a strong tendency on the part of some foundrymen to assume what is convenient rather than to investigate whether such assumptions are correct. This is particularly noticeable when a discussion arises on the mineral constituents of sands. It is only misleading to assume that the greater part of "other minerals" in sand are composed of felspar, and a number of erroneous conclusions have in consequence been made with regard to moulding sands.

Comparisons of the proportion of alumina in various samples, though very common, are particularly misleading, as the alumina is a constituent of many minerals occurring in sands, and the extent to which it is present gives no idea whatever of the amount of the mineral of which it forms a part.

It is in consequence of these difficulties that the greatest caution is needed before an opinion as to a sand can be rightly expressed, and it is quite true to state that, at the present time, there is no simple means of ascertaining the true composition of a sand or loam; expert knowledge of micrography, as well as of analysis is essential.

Clay.

Clay is an almost invariable constituent of British sands, although in some of them it must be present in very small proportions. Some idea of the amount may be gained by shaking up the sand with 20 times its weight of water in a tall glass cylinder and noting the amount of matter remaining in suspension after one minute. The test is vitiated by the extremely fine sand present, some of which will remain in suspension for an hour or more.

One of the most valuable characteristics of clays is their plasticity, but, unfortunately, no one has yet succeeded in measuring this property in a really satisfactory manner when the clay is mixed with a large proportion of sand. So little is known of plasticity that it is by no means clear that it has any connection whatever with the composition of the material. Two clays may have the same chemical composition, yet their relative plasticities may be widely different.

It was thought at one time that the power possessed by clay of binding or absorbing certain aniline dyes might provide a means for determining the proportion of clay present, but more careful experiments have shown that this method gives very irregular results with different sands, though useful in checking the clay-content of different batches of the same sand. Further investigations are now being made in this direction.

The writer has examined many sands for various purposes and has found that a carefully arranged system of washing is the simplest means of separating the clay from the other constituents. This may be most readily carried out by stirring a convenient quantity of sand with water in a small tank containing paddles. The overflow from this tank is received at the bottom of a larger conical tube in which the water flows at the rate of 0.43 in. per minute. This is sufficient to carry away all the clay together with a little of the finest sand. The product is never pure, and usually contains half its weight of sand, but this is the purest product at present obtainable. To obtain the best results very small quantities of sand must be employed, and a Schoene's elutriating funnel used. Various processes of sedimentation have also been tried, but are less satisfactory. Unfortunately, no means of definitely separating the extremely fine grains of sand from those of the clay have yet been discovered, as their specific gravities are almost identical, and no chemical reagent is known which will attack either the clay or the sand without interfering with the other. The errors of "rational analysis" have already been pointed out.

Colour.

The colour of moulding sands is unimportant, except as a rough guide to the form in which the iron is present, red sands indicating free ferric oxide This oxide is understood to assist in putting a good "skin" on castings, but it has the serious disadvantage of being reduced by the coal- or coke-dust mixed with the sand, thereby forming fusible ferrous silicates which bind the sand grains into lumps, and, when sufficient of these are present, rendering it "dead" and useless. Various oxidants are used to prevent the occurrence of this reduction or to "revive" the sand in which it occurs: it is, however, better to use sand containing less iron oxide and never to use that which contains more than 5 or 6 per cent.

Refractoriness.

Refractoriness or resistance to heat in a sand depends on the proportion of "other minerals" present and on the fineness of the grains of quartz, etc. Sand is usually so refractory that a direct test of its heat-resisting powers is of little value. The writer prefers to separate the sand into two portions by means of a No. 150 or 200 sieve, and to test the heat-resistance of the material which passes through the sieve. In this way, the coarser, refractory particles are removed, and the finer and more fusible ones are isolated, so that their presence and effects are more marked. As it is not the absolute refractoriness that is required, but only the tendency of the sand to vitrify or fuse in places, this separation of the more fusible constituents is of value.

The fine material (or if preferred the original sample) is mixed with a little dextrine and water and is moulded into a small pyramid about 2½ in. high with a triangular base with ¾-in. sides. This pyramid is heated in a test furnace along with Seger cones and the number of the latter corresponding in behaviour with the test piece is taken as the refractoriness of the sample.

Porosity.

The porosity of a moulding sand is of smaller importance than is generally supposed. It is not the

number or size of the pore-spaces between the solid grains of the sand, as received, that matter, but the facilities for the escape of gases offered by the sand when made into a mould. A sample of sand may be very porous when placed in a test glass or cup, but it may be very unsuitable for moulding because, when rammed to form a mould, the gases cannot escape. The writer has made numerous comparisons, but has been unable to trace any direct connection between the porosity of sands "as received" and their suitability for moulding. He therefore regards a porosity test as of minor importance.

Permeability.

The permeability to gases of a mould made of sand, on the contrary, is of great importance, and no tests of moulding sands can be complete without it. Unless the gases formed during casting can escape with sufficient rapidity, "scabs" are formed and defective castings are produced. The permeability of a mould depends partly on the shape of the casting and on the skill of the moulder as well as on the sand-mixture used, and in any test of this property due importance must be attached to the "personal element." The writer has obtained the best results in the following manner :—

A mould case is used which consists of a circular metal box, 3 in. diameter and 1¼ in. deep, with the bottom cut out and replaced by wire gauze of any convenient mesh. On the bottom of this case a sheet of thin porous blotting-paper is laid and the case is filled with the sand to be tested, care being taken to ram it in a manner as similar as possible to that employed when an ordinary casting is to be made. The sand or sand-mixture should be precisely 1 in. thick. In order to preserve the conditions of normal ramming the writer frequently places the empty test case in a larger mould in course of formation, and removes it when filled, the space left in the larger mould being afterwards repaired. The case is filled by laying on a second sheet of paper and by inserting a flanged pipe, the whole being then clamped firmly, but without breaking the structure of the sand. Water is poured into the flanged tube to a height of 40 in. and the appliance is suspended above a glass receiver or measure. The time taken for 100 c.c. of water to flow through the sand into the receiver is a measure of the permeability. In exact experiments the level of the water in the flanged tube must be kept constant.

If care is taken in making the test, results from similar sands are very constant, but test blocks made by different moulders differ so greatly that no comparison is possible. Hence in testing fresh deliveries of sand it is important that all the test pieces shall be made by the same moulder. At the present stage this test is of value in works for the manager's own use, but not for comparison with the results obtained by others; the differences caused by unconscious variations in manipulation are too great. In a modification of this test the writer endeavoured to substitute air in place of water, but the variations in the amount of air penetrating through the same block at different times as well as with different tests of the same sand made the use of air appear to be impracticable. Further experiments are, however, being made in this direction.

Fineness.

The fineness or size of grains of sands used for moulding has never been standardised and equally good results have been obtained with sands of most divergent characteristics in this respect. In comparing the fineness of different samples of sand, the writer has found an adaptation of Jackson's "Surface factor" is convenient providing the material is not too coarse. The writer has for more than ten years used a series of sieves with 10, 25, 50, 100 and 200 holes per linear inch.

Since the standardisation of sieves by the Institute of Mining and Metallurgy it is best to use standard sieves; these are made by N. Greening & Son, Warrington. The sizes of the apertures of the sieves are given in a subsequent table.

The sand is mixed with water, well shaken for half an hour or more in a mechanical agitator and then run on to each of the sieves in turn. Each sieve is then washed with a powerful "rose" of water so as to ensure all the sand finer than the mesh running on to the next finer sieve. The contents of the various sieves are then dried and weighed. The material which passes through the finest sieve contains all the clay together with an equal weight, or more, of sand. This mixture is placed in a Schoene's elutriating tube and water is passed through it at the rate of 0.43 in. per minute. In this way a further portion of very fine sand remains in the vessel, the clay with some sand being washed out by the water. This clayey portion is collected, dried and analysed; its composition will give a fair idea of the proportion of clay present.

Surface Factor.

The surface factor is found by muliplying the weight of each fraction separated in this manner by an appropriate factor and adding all these numerical products together. The factors for multiplying are shown in the following table, from the writer's "Clayworkers' Handbook" :—

	Sieve.	Diameter of particles.	Nature.	Factor.
A	On Sieve No. 1	Above 0.5 in....	Stones ...	*Nil.*
B	Between Sieves Nos. 1 and 10.	Above 0.05 to 0.5 in.	Gravel ...	0.27
C	Between Sieves Nos. 10 and 50.	Above 0.01 to 0.05 in.	Course sand	2.6
D	Between Sieves Nos. 50 and 100.	Above 0.005 to 0.01 in.	Medium sand	13.2
E	Between Sieves Nos. 100 and 200.	Above 0.0025 to 0.005 in.	Fine sand	22.6
F	Between Sieves Nos. 200 and washing.	Above 0.0004 to 0 0025 in.	Silt ...	53 9
G	Washed out by a stream 0.43 in. per min.	Below 0.0004 in.	Clay and dust	359.0

If the weight of each fraction be represented by the letters in the first column in the above table, the surface factor is :—

$$0.27B + 2.6C + 13.2D + 22.6E + 53.9F + 359G.$$

The finer the sand, the higher will be the surface factor. As the factor for stones is *nil* the weight of stones present does not enter into the calculation except in so far as it reduces the total forming the surface factor.

The use of this factor in comparing several well-known moulding sands is exemplified in the following table, in which the letters indicate the proportion of each of the grades, as above :—

Sand.	A.	B.	C.	D.	E.	F.	G.	Surface factor.
Medium Erith ...	—	0.03	1.19	0.34	42 74	28.5	27.17	12,205
Fine Mansfield ...	—	—	1.50	3.92	40 63	31 73	22.21	10,657
Coarse Mansfield ...	0.01	0.74	3.36	18.42	67.17	6 49	3.81	3,497
Stourbridge	—	0.22	5.36	18.93	54.76	14 61	6.08	4,472

By means of this surface factor a single expression is used for the fineness of a sample of sand and a ready method of comparison is obtained. The differ-

ence in texture between the fine and coarse Mansfield sands is well shown in the table, the Erith sand corresponding with the former and the Stourbridge with the latter.

Sharpness.

The sharpness of sand cannot be expressed numerically, but a careful microscopical examination will usually enable the relative angularity of the grains of two samples to be determined in a few minutes.

Strength.

The strength of sand when in the form of a mould is another property for which no satisfactory method of measurement has been found. The measurement of the tensile strength of test pieces made with fixed weights of sand, water, and dextrine has not proved satisfactory, and the sand, as actually used by moulders, has so little compressive or tensile strength that the errors of experiment are so great as to destroy the value of the results. The writer has ascertained the maximum weight which can be carried by a cube of sand of 2-in. sides, the weight being applied in the form of a light aluminium cylinder with a large base. Water or mercury is run into the cylinder until the cube of sand loses its shape. So far the results, though interesting, are far from constant with different batches of the same sand, though consecutive cubes made from a small sample yield constant results.

Dead Sand.

Dead sand is that which has been mixed with coal dust, has been used a number of times by the moulders and has lost its valuable properties. Dead sand is deficient in plastic clay, as may readily be seen by examining the finest portions removable from the material by a slow stream of water. It also contains a larger proportion of sand grains which have been fastened together by the fusible silicates produced by the reaction of the coal dust on the iron oxide and silica in the material. Dead sand has a very low surface factor—in the specimens examined by the writer this varied from 437 to 1,025—and as it does not pay to grind it and so increase the surface factor, dead sand can only be used to a very limited extent along with new sand.

In spite of the difficulties experienced in testing sands and in formulating satisfactory conclusions from the results of such tests, their value is unquestionable, and as users of moulding sands accustom themselves more and more to the study of the properties of the sands they use, the greater will be the progress made in obtaining satisfactory castings. In Germany, where the use of artificial mixtures of various sands is common, the writer has found an increasing tendency to detailed standardisation of the different sands employed; in this country, on the contrary, moulders are blessed with natural sands of sufficiently suitable composition and physical properties, and there is less inducement to improve these natural materials. Nevertheless, a careful study of the tests suggested in this Paper, combined with that of actual castings produced from known sands and mixtures, has convinced the writer that the use of such improved sands is one of the great needs of the industry at the present time. The chief difficulty is that the most effective tests are beyond the capability of the ordinary foreman, whilst many of those who have the ability for carrying them out do not have access to a sufficient number of foundries to be able to draw general conclusions. It would be well if this Association could undertake a general investigation into the matter.

Discussion on Moulding Sands.

The discussion was opened by the Secretary reading a letter from Mr. J. Shaw, of Dudley, who was absent on account of sickness.

Mr. Shaw wrote:—"I should be glad if you would ask the author to give definite methods that he would suggest for foundrymen to help in placing the subject on a comparative basis. The information given in the Paper, while very good, is destructive, and not constructive. Everyone using the 'rational analysis' knows it is not quite correct, but it is found to be of so much value to brickmakers and patters, that its extension to sand analysis might be of value. In any case, it is quite as useful as a complete analysis, as we have to take for granted the analysis of the felspars, etc., in making our deductions. Will the author lay down some lines on which we can compare sands whose chemical analyses vary little, but which, under similar conditions, show varying tendencies to scab, etc."

Mr. S. G. Smith (Chesterfield) was afraid that the ordinary method of reporting the results of sand analysis did not give the information required by the moulder. He did not decry analysis, for some years ago, when he was interested in moulding sands, he tried to find some means of standardising from analysis certain mixtures of sand for certain classes of work. He would not say that had failed; he could give roughly the analysis of sands which were suitable for certain classes of work, but the table was not complete. He knew several large firms who were using large quantities of sand, and were working by analysis; but in many other cases the users did not know the analysis of the sand they were using, and those who supplied the sand did not know it. Where there was a wide variety of work, they ought to know the different sands by analysis, and how to mix them to get the best results. In some small foundries it might do to use the sand just as it came in, but in large foundries it was a very different matter. It was of far greater importance to know how to manipulate, grade, grind and treat the sands to suit the several kinds of castings required than to know the analysis, either ultimate, rational, or even the colloidal state of the clay matter. He classed sands as "weak," "medium" and "strong," and mixed them together in different proportions, adding when necessary the clay, manure, sawdust or chaff, all as necessary to suit the work. The proper selection or mixing of the sand was of very great importance to the moulder. To emphasise this, he would mention that during the past year they suffered from a certain difficulty in castings, what he would call a liquid or fluid fracture, *i.e.*, a fracture taking place in the casting before it was set. That was something new: and it got to be very expensive, as it caused a large percentage of the work to be bad. The work was not under his control at the time, and it was difficult for those in charge to get to know what was the cause. Eventually the work was put under his supervision. It was quite a little work of research and experiment, but he traced the difficulty to two main reasons. One of the principal was the irregularity of the preparation of the sand that was used. He had to confess that though he had had 25 years' experience of that sort of work, he did not in this case hit the real cause of the trouble straight off. Such things as these showed the importance of studying the treatment of sands after they had been got from the quarry. (Applause.)

The President intimated that any further remarks or questions on the Paper might be submitted in writing.

Mr. Searle, in reply to Mr. Shaw, explained that one of the objects of his Paper was to draw attention to erroneous methods of testing sands and to the serious results which accrued from conclusions drawn from such methods. The "rational analysis" had "fogged" the whole subject of the constitution of clays for many years past, and instead of being as useful to brickmakers and potters as Mr. Shaw suggested, it had really had a most detrimental effect. The good it had done had been confined to clays of a certain type which did not occur with moulding sands, and the application of the rational analysis to sands must lead to false conclusions. The author disagreed entirely with Mr. Shaw's statement that the rational analysis was "in any case quite as useful as a complete analysis"; indeed, his Paper and the remarks made above led to precisely the opposite conclusion. The reasons why rational analysis was almost valueless and conclusions drawn from it erroneous, might be explained much more fully than in the Paper, but such explanation involved such a knowledge of theoretical chemistry that it was thought that it would be of little interest to members of the Association. Consequently, only the author's conclusions as to its value were stated. The value of a moulding sand and its tendency to scab, etc., was not shown by its chemical composition alone, but had to be ascertained from the results of a combination of physical and microscopical as well as chemical tests, some of which were extremely delicate and difficult of interpretation. There was, unfortunately, no simple method which could be placed in the hands of a foundry foreman, as the variations in character which caused some sands to produce defective work were so small that the use of instruments of great delicacy was necessary, and specially skilled testers would have to be employed.

The author had for several years been successfully using a combined method of testing which apparently met all the requirements of founders, especially as regards sands of very similar chemical composition which differed greatly in use. His existing arrangements with some of his clients did not permit him to disclose the details of this method at the present time, but he hoped to be able to do so in the near future in a further Paper before the Association. Meanwhile, he asked the members of the Association to accept only with the greatest reserve any conclusions based on "rational analysis" or any other purely chemical method of testing.

Gates for Moulds.

Writing in "Southern Machinery" on the subject of "Gates for Moulds," J. B. Thurman states that, just as much care should be taken in preparing that part of the mould through which the gate is cut as any other part, because good, clean metal can be spoiled by pouring it into a dirty gate, or one that is rammed too hard. It is well known by every moulder that the instant the hot metal touches a hard gate it begins to boil and bubble in such a way as completely to change the nature of the metal from what it was in the ladle or crucible.

One of the best gates that can be used, especially for medium or heavy castings, is shown in Fig. 1. It is known as the whirl gate. The metal enters the pouring gate at A and runs into whirl B, where it begins a rotary or whirling motion because of the angle at which it enters. On the other side of whirl B is the continuation of the gate to the mould, leaving the whirl at the same angle as entering, except on the opposite side. On top of the whirl is placed a head, at least twice as large as the pouring gate A. So that any accumulation of dirt in the whirl is carried into this large opening and kept from entering the mould through gate C. One important point should always be observed in using this gate, and that is that the section of gate from A to B should always be a little larger than the gate from B to the mould, so as to put the pressure on the whirl. If this were reversed and the gate from B to the mould were larger than the gate from A to B, the metal would never rise above the gate C, and its effect would be lost.

Another gate that is commonly used is known as the choke-gate, and has a larger sphere of usefulness than any gate. Many castings of certain character are lost by failure to use this gate properly, and their loss is attributed to other causes. Except in cases of very thin castings, the metal should always enter the mould as quietly as possible, for if it is allowed to enter gently the danger of cutting and washing is

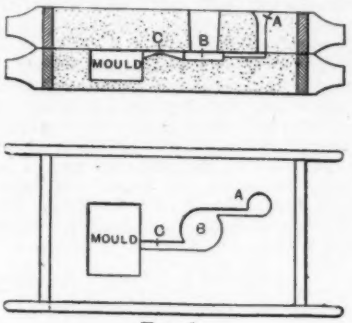


Fig. 1.

greatly reduced, even in plain ones, while in the more complicated ones the value of this gate is proportionately greater.

Take, for example, a web pulley, Fig. 2. If this character of a mould is gated correctly it needs but little anchorage, for if the pressure of the metal being poured is checked at a point away from the mould, instead of at the point of entrance, the result is a quiet entrance of the metal that does the least possible harm. Fig. 2 shows this gate in its proper form. Beginning at pouring gate D, the size of gate is gradually reduced till a point about midway between the pouring gate and mould is reached; then it increases in size to the mould. Fig. 2 shows a section of the pulley and the gate. If the gate is cut so as to choke at the point of entrance, the metal is inclined to bound over the rim

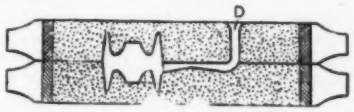


Fig. 2.

of the pulley, filling the hub first and placing all the pressure on the green-sand core that fills the space between the rim and hub of the casting. Unless this core is thoroughly secured with gaggers, the pressure from inside will burst the walls of the core, and the casting be ruined. By using the choke-gate as described, the pressure being checked before it reaches the mould, the metal flows through the end of the gate, filling the rim first, then flowing over the sides of the core and filling the hub last.

The reason the size of the gate is not steadily increased from the pouring gate to the mould is that under such circumstances it would be practically impossible to keep the pouring gate full of metal, as should be done, since there is no means for carrying off the dirt or skimmings. By keeping the gate full, all foreign matter floats to the top of the gate instead of being washed into the mould.

The Influence of the Shape of Test Bars on the Mechanical Properties of Cast Iron.*

The following report of their investigation on the influence of the shape of the test bar on the mechanical properties of cast iron, as shown by comparative tests made on the standard bars of English, German and American section, was submitted by the English Committee to the International Association for Testing Materials at the New York meeting. Two series of cast test bar were made at different foundries, one at Middlesbrough and one in London. Messrs. Richardsons, Westgarth & Company cast at their works in Middlesbrough the first series of bars of a good foundry mixture such as is commonly employed for good average castings. Four bars each of the English, German, and American standard test bars were cast all from the same ladle of metal; two in each were cast when about one-fourth of the metal had been poured from the ladle, and two of each when about three-fourths of the metal had been poured from the ladle. Mr. W. G. Kirkaldy, of Messrs. David Kirkaldy & Sons, undertook to carry out the mechanical tests.

obtain the results from bars of an entirely different mixture cast under different conditions, Mr. Kirkaldy arranged with Messrs. Young & Company, London, to cast another series of bars under his supervision, and these were duly cast in his presence. Full details of the results obtained are given in Tables III. anad IV., and the analyses made by Dr. Stead and Mr. Harbord independently are also given. In these sets six of each of the standard bars were cast, four of each on one day from the same ladle and the remaining two of each on another day. In the transverse tests the maximum difference in ultimate stress taken on the sound bars in the case of the English test bars was 472 lbs., and the maximum difference in deflection was 0.05 in. In the case of the German bars, calculated to the equivalent load upon the English standard bar, the maximum difference in ultimate stress was 464 lbs., and the maximum difference in deflection was 0.09 in., and on the American bars the results were respectively 456 lbs. and 0.03 in. deflection. The smaller difference in deflection in

TABLE I.—*Analyses by Messrs. Edward Riley and Harbord of Cast-Iron Bars.*

Marks.	Total Carbon.	Graphitic Carbon.	Combined Carbon.	Sulphur.	Silicon.	Phosphorus	Manganese.	Arsenic.	Copper.
A	3.480	2.700	0.780	0.099	1.405	1.165	0.418		
A	3.406	2.675	0.731	0.096	1.429	1.139	0.416		
A	3.428	2.790	0.738	0.095	1.443	1.110	0.403	0.014	
B	3.450	2.670	0.780	0.098	1.557	1.161	0.422		
B	3.519	2.844	0.622	0.101	1.606	1.047	0.414		
B	3.387	2.684	0.703	0.110	1.617	1.098	0.422	0.011	
C	3.459	2.671	0.795	0.094	1.485	1.144	0.414		
C	3.456	2.684	0.771	0.101	1.433	1.101	0.403		
C	3.466	2.686	0.780	0.098	1.462	1.156	0.406	0.012	
Average ..	3.450	2.711	0.745	0.099	1.493	1.123	0.413	0.012	0.053

TABLE II.—*Average Analyses of Cast-Iron Bars.*

Analysis made by	Total Carbon.	Graphitic Carbon.	Combined Carbon.	Sulphur.	Silicon.	Phosphorus.	Manganese.	Arsenic.	Copper
Edward Riley and Harbord ..	3.450	2.711	0.745	0.099	1.493	1.123	0.413	0.012	0.053
Pattinson and Stead	3.400	2.695	0.705	0.108	1.400	1.117	0.403	0.012	0.047

The transverse tests of the four German and four American bars were calculated to the equivalent load of the English bar. In each case one of the bars had a slight defect, but eliminating three bars the maximum difference in load in the English was 696 lbs., in the German 48 lbs., and in the American bars was 192 lbs. The maximum difference in deflection in the English was 0.04 in., in the German 0.02 in., and in the American bars was 0.02 in. In the case of the bars for tensile strength the maximum difference in ultimate stress on the English bars was 0.4 ton, in the German bars 0.7 ton, and in the American bars 0.5 ton. The mean results obtained on the English bars were exactly one ton less than the German and American bars, the results of the two latter being identical. Unfortunately, by an oversight the English bars were cast on the flat instead of on the edge, as is the usual practice; in the case of bars cast on the flat, any little unsoundness such as a blowhole appreciably affects the transverse strength of the bar when tested on edge. For this reason, and also to both of the American sets of bars was to be expected, owing to the shorter length of the test bars, and consequently much smaller total deflection obtained.

The results of the experiments on the tensile strength, eliminating the unsound bars, show, in the English, a difference of 0.4 ton, in the German 1.3 ton, and in the American bars 0.8 ton. The average of all the bars shows that the English test bar gives a slightly lower result than the German and American, the two latter being almost identical, but if the unsound bars in the English series be omitted the average of these is slightly higher than either the American or the German. It should be noted that in this series the English tensile tests were made without removing the skin, as has been the practice for many years, whereas in the case of the German and American it was necessary to remove the skin to obtain a suitable specimen, apart from fulfilling conditions laid down in the specification. Broadly, looking at the results obtained, the shape of the bar seems to have little effect on the physical properties, provided the bars are sound; but it would appear that there is a little more difficulty in ensuring sound bars cast to the English section than in the case of either the American or the German bars.

* Report of the English Members of the Committee on Testing Cast Iron to the International Association for Testing Materials. Presented by Dr. J. E. Stead.

In view of the small differences obtained with the bars of different shapes, the Committee do not feel that the results call for any recommendation, except that they do consider it desirable that any bar for testing for deflection by transverse stress should not be less than 24 in. long, as with shorter bars than this it is very difficult to measure to the required degree of accuracy except with very delicate measuring instruments, and any slight error which would be liable to occur under ordinary works conditions of testing would be greatly magnified by using a shorter bar than this.

TABLE III.—*Transverse Strength, etc., of Cast-Iron Bars.*

Test No.	Description.		Dimensions.	Span.	Ultimate stress.	Ultimate deflection.	Calculated equivalent load upon English standard bar 1″×2″ 36″ span.	Appearance of fracture.
			inches. B D	inches.	lbs.	inch.	lbs.	
1	English Standard 1″×2″ 3′ 4″ long. Cast on edge	A.....	1.03×2.06	36	3,480	0 42	3,184	Sound
2		A.....	1.03×2.03	36	2,7.0	0.34	2,612	Skin defect (bottom edge).
3		B.....	1.02×2.05	36	3,420	0.42	3.188	Sound.
4		B.....	1.01×2.04	36	3,020	0.38	2,876	do.
5		C.	1.03×2.06	36	3,660	0.43	3,348	do.
6		C.	1.02×2.03	36	3,290	0.40	3,132	do.
				Mean	3,273	0.40	3,057	
			Round Bars B D	23.62″=				
7	German Standard 1⅛″ dia. 25½″ long.	A.....	1.22×1.24	600 mm	1,800	0.41	3,192	Sound.
8		A.....	1.21×1.22	,,	1,630	0.35	3,032	do.
9		B.....	1.20×1 25	,,	1,590	0.32	2,840	do.
10....		B.....	1.22×1.28	,,	1,860	0.38	3,108	do.
11....		C.	1.23×1,21	,,	1.540	0.34	2,864	do.
12....		C.	1.25×1.23	,,	1,540	0.35	2,728	do.
				Mean	1 660	0.36	2,961	
			Round Bars B D					
13....	American Standard 1½″ to 1⅝″ dia. 15″ long.	A.....	1.23×1.27	12 ins.	3 050	0.12	2,624	Sound.
14....		A.....	1.23×1.25	,,	3,360	0.15	2,968	do.
15....		B.....	1.23×1.25	,,	3,490	0.12	3,080	do.
16....		B.....	1.26×1.28	,,	3,690	0.14	3,036	do.
17....		C.	1.25×1.26	,,	3,280	0.15	2,804	do.
18....		C.	1.24×1.26	,,	3,430	0.13	2,952	do.
				Mean	3,383	0.135	2,910	

TABLE IV—*Tensile Strength, etc., of Cast-Iron Bars.*

Test No.	Description.		Dimensions.		Ultimate Stress.		Appearance of fracture.
			Dia.	Area.	Total.	Per square inch.	
			inch.	sq. ins.	lbs.	lbs. tons.	
1a....	English Standard Tensile bar, Tested with skin on	A.....	1.25	1.227	38.490	31.369=14.0	Sound.
2a....		A.....	1.25	1.227	38.400	31.296=14.0	do.
3a....		B.....	1.28	1.287	31.590	24.545=11.0	Slightly unsound.
4a....		B.....	1.25	1.227	37.320	30.415=13.6	Sound.
5a....		C.....	1.26	1.247	38.700	31.034=13.9	do.
6a....		C.....	1.27	1.267	33.720	26.614=11.9	Slightly unsound.
					Mean	29.212=13.0	
			turned				
7a....	German Standard, Specimens prepared from bars after testing under bending	A.....	0.798	0.500	15.420	30.840=13.8	Sound.
8a....		A.....	0.798	0.500	15.080	30.160=13.5	do.
9a....		B.....	0.798	0.500	14.040	28.080=12.5	do.
10a...		B.....	0.798	0.500	14.480	28.960=12.9	do.
11a...		C.....	0.798	0.500	15.540	31.080=13.9	do.
12a...		C.....	0.798	0.500	15.260	30.520=13.6	do.
					Mean	29.940=13.4	
			turned				
13a...	American Standard Specimens prepared from bars after testing under bending	A.....	0.798	0.500	15.500	31.000=13.8	Sound.
14a...		A.....	0.798	0.500	15.340	30.680=13.7	do
15a...		B.....	0.798	0.500	14.600	29.200=13.0	do.
16a...		B.....	0.798	0.500	15.180	30.360=13.6	do.
17a...		C.....	0.798	0.500	15.200	30.400=13.6	do.
18a...		C.....	0.798	0.500	14.780	29.560=13.2	do.
					Mean	30.200=13.5	

In the round bars the indicated joint of mould was placed in neutral position in each case. In calculating the results of the round bars to obtain their equivalent upon bars 1″×2″ (English section) the rounds have been considered with regard to section as equal to 0.7854 of the $B\ D^2$. The bars marked A and C were cast on the same day from the same ladle. Those marked B were cast on another occasion.

Coking Practice in the South Wales District.

By R. H. Greaves (University College, Cardiff).

Much more importance is at present attached to the selection of coke used in foundry work than formerly, and this care is not misplaced, as it leads to economy in melting and a higher quality of metal. In attaining the former result the physical character of the coke and the amount of ash are of importance: a high ash means a correspondingly low percentage of combustible matter, and also increases the amount of flux to be used. Sulphur present in the coke passes, to a considerable extent, into the metal, and exerts its own influence. In many cases in which castings come out hard the metal is blamed, whereas the fault lies entirely with the coke used; when coke is high in sulphur, the best metal will be ruined.

In view of the importance of coke as a factor in foundry work, a short account of the production and character of South Wales coke may be of interest during the visit to that district.

Welsh Coals.

The South Wales coalfield covers an area of nearly 1,000 square miles, and extends over the greater part of Glamorgan and Monmouthshire and into the counties of Pembroke, Carmarthen, and Brecon. The character of its coals—in some cases unique—is illustrated by the following typical analyses:—

Type of Coal.	Moisture	Ash.	Volatile Matter.	Fixed Carbon.
	Per cent	Per cent	Per cent.	Per cent.
Monmouthshire Bituminous ..	1.0	6.8	27.5	64.7
Steam ..	1.0	3.5	21.3	74.2
Best" Welsh Steam—Rhondda Valley	1.0	3.5	14.0	81.5
Dry Steam—Aberdare Valley .	0.7	2.5	11.5	85.3
Anthracite—Swansea district .	0.9	2.3	5.1	91.7

The distribution of these types of coal conforms to two general rules—(i.) on passing towards the N.W. and W. the seams become more and more anthracitic; while (ii.) at any given point, the lower seams have the smaller volatile matter.

The true coking coals, containing upwards of 20 per cent. volatile matter, are thus found round the S. and E. outcrops of the coalfield and in the upper seams of the central districts. The small of steam coal and anthracite, of course, does not coke, but is admirably suited for the manufacture of briquettes or patent fuel, an industry in which South Wales takes the foremost place. The following are examples of Welsh coking coals:—

Seam.	Moisture	Ash.	Volatile matter.	Fixed Carbon.	Sulphur.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Black Vein	0.80	4.28	25.64	69.28	0.6
Brithdir	0.90	2.60	26.0	70.5	2.6
No. 3 Rhondda ..	1.50	2.50	24.8	71.2	0.8

As so many of the Welsh coals are non-caking, it is usual to mix these with caking coals in certain proportions. This practice dates from 1850, when a patent was granted to Mr. J. P. Budd, of Swansea, for the manufacture of coke from a mixture of non-caking and caking coals. From time to time coke has been made from pitch, and from crushed anthracite and pitch in varying proportions, but this has been given up. It is not likely that with pitch at its present price of 54s. per ton much will find its way to the coke oven. Pitch coke was strong, hard, exceedingly low in ash, and although somewhat porous, melted a very hot iron.

Local Conditions.

The mixture of coals is made as a rule to contain about 20 per cent. of volatile matter. This is a much lower figure than is employed in other districts; it accounts for differences in the development and present practice of coking in South Wales as compared with other coalfields, and also has an influence on the nature of the coke.

(i.) There is a larger yield per ton of coal and a proportionately lower ash and sulphur. It is evident that a coal containing 5 per cent. ash will give a coke containing $5 \times \frac{100}{70} = 7.14$ per cent. ash if the coke yield is 70 per cent.; whereas with an 80 per cent. yield the ash would be only 6.25 per cent.

(ii.) In the North, coals with 30 to 35 per cent. volatile matter are converted into fairly dense coke by compressing the slack in the ovens. Compression is never practised in South Wales, and would be undesirable, as the coke produced is already sufficiently dense. Moreover, the contraction on coking is small, and coke so compressed could not be easily pushed out of the ovens.

(iii.) It is now well recognised that a low volatile coal requires more rapid heating in order to obtain a satisfactory coke than a more bituminous one.

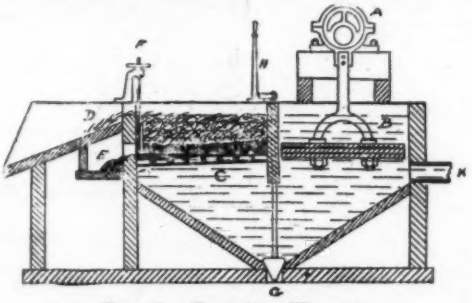


Fig. 1.—The Jig Washer.

This fact was early recognised in practice; it explains the widespread use in South Wales of the old Welsh oven to the exclusion of the Durham beehive, and the great popularity of the early retort ovens of the Coppée type.

Coal Washing.

Coke is produced from small coal; no large coal is ever used in any of the modern ovens. A large amount of slack is employed, and this generally contains an admixture of shale, which brings the ash up to 20 or 30 per cent. Before coking this is removed in a washery. The procedure varies with the system of washing employed, but in general coals are mixed in the required proportions and screened to separate different sizes—nuts, beans, peas, etc., each of which is washed separately; only coal of perhaps 5/16 in. or less is sent to the ovens. The principle of many types of washery is shown in Fig. 1.† Coal on the grid is washed by water supplied through K and kept in a state of agitation by the motion of the piston B. For the smalls, there is a layer of felspar on the grating. This is intermediate in density between coal and shale, and serves to effect a more complete separation. The fine dust passes through the grid and is from time to time collected at G,

*Presented before the Cardiff Convention of the British Foundrymen's Association.

†Taken from Byrom and Christopher's "Modern Coking Practice," where a full description of most of the plant mentioned in this paper will be found.

the larger shale is run off at E, while the coal is washed over at D. The most important washeries at work in the district are the Coppée, Sheppard, Humboldt, and Baum; trough washers, such as the Elliott and Blackett, are also in use.

In washing, the ash is reduced from 20 or 30 per cent. to 6 per cent. or under; that is to about 2 per cent. more than the ash of the pure coal. For example, in a case in which the ash of the absolutely clean coal was about 3 per cent.—

Before washing,	whole coal contained	15.0	per cent. ash.
After washing	smalls	5.5	"
	beans	4.0	"
	nuts	3.3	"
	dust	8.2	"

Ash is difficult to remove from the very fine dust, and this is never used for better-class coke. Sulphur is very considerably reduced during washing, a large amount which occurs as "brasses" or iron pyrites being removed. Phosphorus, on the other hand, is not reduced, the coal substance apparently containing about the same percentage as the shale.

The washed "smalls" are carried on an endless chain of buckets to bunkers to drain, the moisture being thus reduced to about 10 per cent. From the bunkers the coal is run in small trucks to the top of the ovens.

Development of Coking in South Wales.

The coke first produced in Wales was used entirely in the local ironworks. Up to 1840 Welsh ironmasters had never attempted any improvements on the old method of coking in piles covered with wetted coke-dust from a previous operation. This method was soon abandoned at Merthyr, where the coal used passed "almost unchanged into a ponderous coke resembling anthracite." In many of the Monmouthshire works, where a more bituminous coal was available, the method was used at a very much later date. The piles were generally circular, about 18 ft. in diameter and 6 ft. high, and were arranged round a central chimney, through which they were fired. At Coalbrook Vale, Cyfarthfa, and other places, long piles, termed "pits," were made 12 ft. wide, 3½ ft. high, without any central chimney; these were ignited at the top, and damped down with wet coke dust until coked through, then quenched with water. Kilns were used for a short time, precisely similar to the Schaumberg kiln, though they were independently designed. The method was soon abandoned, and all traces of the kilns have disappeared. The coke had to be drenched with water, frequently taking up 20 per cent.; at the Dowlais works the yield was reported as "very bad indeed"; while the manager of the Ebbw Vale Company, commenting on the manner in which the coal burnt away, observed, "You might hunt badgers through the coke."

The oldest Welsh ovens were simple arched, rectangular chambers, in which air entered through the top of the door in front, and the burning volatile products escaped through a chimney at the back. At Dowlais Ironworks they were 13 ft. long, 6 ft. wide, and 4½ ft. high to the top of the arch, and produced 50 cwt. of coke in 48 hours. In these ovens slack could be coked, whereas only a small proportion of this could be coked in heaps. The coalowners were quick to take advantage of this to reduce their huge accumulations of slack. No coal was washed before coking, and in many instances coking degenerated into a process for conglomerating small dirty coal, which would otherwise have been wasted. The product of these ovens often contained 20 per cent. of ash, while the sulphur was sometimes as high as 2.25 per cent.

No improvement took place until the Great Western Railway began to use large quantities of coke for their locomotives. This created a demand for a superior product, and more attention was paid to the purity of the coal used, to the design of the oven, and to economy of manufacture.

For the removal of sulphur all sorts of suggestions were made, notably the treatment of the coke with steam and with various solutions, but the only satisfactory method is the use of washed coal. Economy was introduced in working by the use of the waste gases for steam raising. In 1848 blast-furnace gas was first utilised for this purpose at Ystalyfera, but coke-oven gas was not used until many years later. On account of the increased yield and rapidity of coking, the Coppée oven rapidly grew in favour; at present more than 4-5ths of the Coppée ovens of the kingdom are situated in South Wales. They were introduced at Ebbw Vale in 1874, when two batches of 30 ovens were laid down. With the exception of those at Chapeltown, near Sheffield (built in 1873), these were the first in England. They are still working, together with others erected more recently. Until 1903 no by-product ovens were to be found in South Wales. There were very few tar-distilling works in the neighbourhood to form a local market for the by-products, and this fact, together with the low volatile matter of Welsh coals, made manufacturers somewhat sceptical at the time as to the return to be realised on their outlay. Since 1903, however, a number of by-product ovens of various types have been erected, and others are in course of construction.

Types of Ovens at Present in Use.

The official statistics of the number and kind of ovens in use in 1910 are as follows:—

	Glamorgan.	Mouthshire.	Total for South Wales.	Total for United Kingd'm
Beehive	142	290	432	16,037
Simon-Carves	—	—	—	1,140
Semet-Solvay	—	—	—	1,055
Coppée	1,004	606	1,610	1,991
Bauer	—	—	—	52
Koppers	—	100	100	507
Otto-Hilgenstock	82	—	82	1,025
Simplex	40	—	40	334
Hüssener	—	—	—	249
Others	129	244	373	593
Totals	1,397	1,240	2,637	22,983

Most of the ovens given as beehives do not in the least resemble the round Durham beehive ovens, but are really the Welsh rectangular ovens. The fact that some of these have been returned as "Cox's ovens," and so appear under "others," adds to the uncertainty of the first and last lines.

Welsh Rectangular Ovens: Cox's Ovens.—The original rectangular coking chamber has been modified by the addition of flues, through which air is introduced for the combustion of the volatile matter, and by building gas flues at the side of and beneath the coking space. One arrangement (in use at Blaenavon) is shown in Fig. 2. The hot oven is charged with washed coal through two charging holes in the roof; volatile matter is expelled and burns in the air supplied by the flues A. The hot gases pass into the side flues B, circulate beneath the ovens, and are finally used for steam-raising under boilers. The coke is quenched partly inside and partly outside the ovens, and withdrawn by means of crabs, the floors being sloped to facilitate withdrawal. The ovens are built back to back in double rows, and give a yield of about 57 per cent. of coke. The important modification introduced by Cox is the provision of a second arch inside the oven, called the jack-arch. One of several types of oven in use at Ebbw Vale is

shown in Fig. 3. These are also built back to back; every third oven is charged each day. The charge is introduced through the doorway and piled to a uniform height of 3 ft. 6 in.; the door is then let down and luted with clay. Volatile matter driven off by the heat of the oven burns in the space above the bed of fuel in air obtained through the flue A. The burning gas has to pass to the front of the oven, then over the jack-arch to the main flue and chimney. This is one of the earliest types; modifications include the provision of side flues on the left side of the ovens, and of flues underneath. In this case the air which supports combustion is admitted above the jack-arch, and not into the coking chamber. The charge is withdrawn after three days; yield about 58 per cent.

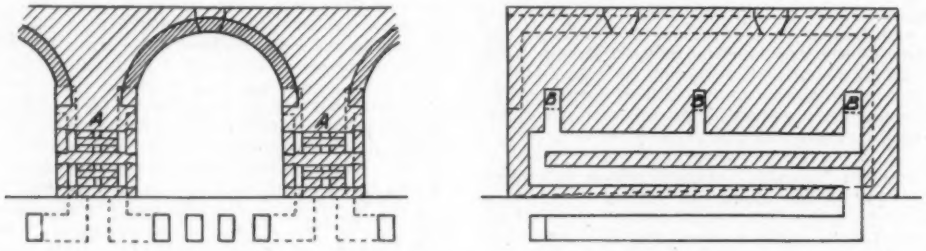


FIG. 2.—WELSH RECTANGULAR OVEN, LENGTH, 18 FT.; BREADTH (BACK), 6 FT., (FRONT), 6 FT. 6 IN.; HEIGHT, (FRONT), 7 FT. 3 IN.

Coppée Ovens.—These are built in batteries of 30, and in pairs, one of each pair being charged when the contents of the other are half coked. The products of distillation from each pair pass to the same flue, thus rich hydro-carbons are supplied by the colder oven when the gas from the hotter begins to get poor in quality. The heat resulting from the combustion of these gases is communicated chiefly to the pair of ovens from which the volatile products have been evolved, by passing them through vertical flues at the sides, and horizontal flues underneath the ovens. The waste heat is utilised under boilers, two of which are generally supplied by each battery of ovens. The yield of coke is about 68 per cent.

By-Product Recovery Ovens.—These may be divided into ovens with vertical flues and those with horizontal flues, each group being further divided into regenerative and "waste-heat" types. In the former, the sensible heat of the escaping gases is communicated to the air drawn into the flues; the gases may then be used in gas engines, or furnaces under boilers, or for illuminating purposes. In the latter type the gases escape at a high temperature, and must be used near the ovens for steam raising.

The only horizontal-flued oven in the South Wales coalfield is the Simplex at the Lewis Merthyr Colliery, Hafod, where 40 ovens of the waste-heat type have been in use since 1909. In this system the gas, after being freed from tar and ammonia, is returned to the oven and burns at jets, each flue being supplied by a separate jet in order to obtain an even distribution of temperature. The hot gases which escape supply heat for four Lancashire boilers.

The vertical-flued ovens used in this district are the Otto-Hilgenstock, Koppers, and Coppée by-product ovens. A battery of 32 Otto-Hilgenstock waste-heat ovens was erected for the Great Western Colliery Company at Pontypridd in 1903, and started working in the following year. These were the first by-product ovens in the district. The purified gas in this case returns to the distributing main, and burns at jets in a long horizontal flue divided at the middle, out of which vertical flues rise at the side of the oven. The burning gases pass along an upper horizontal flue, then downwards on reaching the middle of the oven, and by a sole flue to the waste-gas main, whence they pass under the boilers. At Pontypridd there are 10 burners in the length of the oven (33 ft.); later forms have 15 burners, and differ in the arrangement of flues.

Otto-Hilgenstock ovens of the latest type, with regenerators, are in course of construction at Blaenavon. The spare gas (probably about 50 per cent. of the total, as compared with a maximum of 20-30 per cent. in the waste-heat type) will be applied to gas-engine or furnace work, or partly used for lighting purposes.

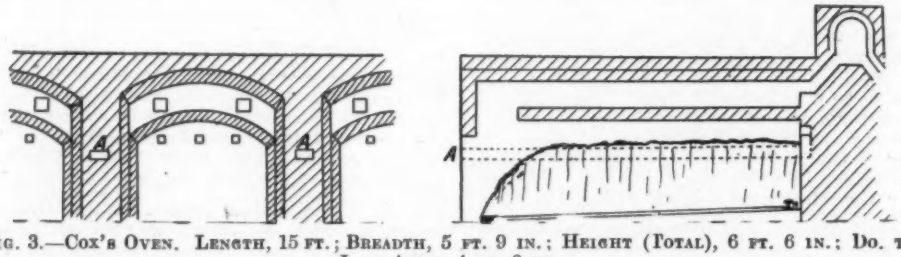


FIG. 3.—COX'S OVEN. LENGTH, 15 FT.; BREADTH, 5 FT. 9 IN.; HEIGHT (TOTAL), 6 FT. 6 IN.; DO. TO JACK ARCH, 4 FT. 6 IN.

Two batteries of Koppers' regenerative ovens have been at work at the Powell Duffryn Colliery, Bargoed, since 1906 and 1907. The first set of 50 ovens has four regenerators common to all ovens, placed longitudinally along the full length of the bench; the second set has a separate regenerator under each oven, the reversing of gas and air being done simultaneously for the whole set. In this oven vertical flues communicate with the gas-distributing channel through orifices, each fitted with a nozzle which may be adjusted from the top of the oven. Dampers regulating the supply of air are similarly controlled, and the temperature of every part of the oven is thus easily regulated. The gas at Bargoed amounts to 10,000 cubic feet per ton of coal, with an average

calorific power of 460 B.Th.U. per cubic foot. It is purified in the ordinary by-product plant, and then deprived of sulphur, which is converted into sulphuric acid for the manufacture of sulphate of ammonia. The surplus gas, which amounts to about 5,000 cubic feet per ton, is used for gas-engines, and, with incandescent mantles, as an illuminant. There are two gas-engines of the Nürnberg type, of 1,200 and 2,400 b.h.p., also one of the Cockerill type, of 650 h.p., to drive a ventilating fan. The consumption of gas per b.h.p. is 21.3 c. ft. (1 c. ft. = 458 B.Th.U.).

The Coppée by-product oven is developed from the original Coppée oven. This type is employed at Lancaster's Steam Coal Collieries, Cwmtillery, and regenerative ovens are in process of construction at the Welsh Navigation collieries, Coedely. One regenerator is connected with the sole-flues of the odd, and the other with those of the even-numbered ovens. The vertical side flues are divided into five sections, each of six flues. Burning gas passes up three of these and down the other three, the direction being reversed periodically. The air supply is driven through the regenerators by a fan, and its direction through the sole flues is reversed with the gas.

The yield of coke made in by-product ovens varies in South Wales between 74 and 80 per cent. of the coal used.

Quenching.

The appearance of the coke depends largely on how quenching is carried out. By quenching out of contact with the air (as in the Durham beehive ovens), a bright, metallic surface is preserved. At Bargoed the coke is pushed out by a ram into a Darby quencher, which is a hood through which water issues at a number of jets and cools the coke in an atmosphere of steam. At other places numerous devices are employed, but it is always important to have a high-pressure water supply; the coke retains much less moisture when quenched with water at high pressure.

Recovery of By-Products.

These are generally recovered in the ordinary way by drawing off the gas through a hydraulic main, then through air- and water-cooled condensers, which bring down most of the tar and ammonia liquor. The exhausters generally used for this purpose are the Bryan Donkin and the Beale. Thence the gas passes to a tar extractor (*e.g.*, the Pelouze), which separates the remainder of the tar, and to scrubbers, where ammonia is removed by a downward stream of water from a sprinkler. Generally there are two scrubbers, weak ammoniacal liquor being used in the first and water in the second. The ammoniacal liquor is pumped to a still where, under the action of steam and lime, ammonia gas is given off. This passes into sulphuric acid in the saturators, sulphate of ammonia separates out, and is dried in a centrifugal dryer. The Wilton sulphate plant is in use at Bargoed, the sulphate being automatically discharged from the saturator into the drying machine.

The direct system of sulphate manufacture is replacing the old method in the newly-built plant. In the Otto-Hilgenstock system the hot gases are drawn through two tar sprays, which remove the tar before any ammoniacal liquor condenses. The gases then pass into saturators. No cooling water is wanted, no ammoniacal liquor is produced, and no lime or steam is required; in the absence of scrubbers, etc., the total space occupied is relatively small.

Yield of By-Products.

On account of the nature of the coal used, the yield of by-products is smaller than in most districts:

Product.	Yield per ton of coal.		
	South Wales.	Yorkshire.	Average for United Kingdom.
Tar	1.5—2.5%	5%	4%
Sulphate ..	18—20 lbs.	22—35 lbs.	24 lbs.
Gas	8,000—10,000 c.ft.	10,000–11,500 c.ft	10,000 c.ft.

A few particulars are here given of the method of coking adopted by most of the South Wales makers:

Name.	Locality.	Type of oven.
Blaenavon Co... ..	Blaenavon	Welsh Rectangular. Otto-Hilgenstock*
Cardiff Collieries Co. ..	Llanbradach.. ..	Otto-Hilgenstock.
Ebbw Vale Steel, Iron and Coal Co. ..	Ebbw Vale and Cwm	Welsh Rectangular Coppée.
Elders Collieries ..	Maesteg..	Coppée.
Gt. Western Colliery Co.	Pontypridd	Coppée : Otto-Hilgenstock.
Guest, Keen, & Nettlefolds	Dowlais : Cwmbran	Rectangular:Coppée.
Lancaster's Steam Coal Co. [Russell's coke.]	Cwmtillery	Coppée by-product.
Lewis Merthyr Collieries Co.	Hafod	Simplex.
North's Navigation Collieries	Maesteg : Tondu ..	Coppée.
Powell Duffryn Co. ..	Bargoed	Coppée : Koppers.
Pyman Watson & Co. [Fforaldu coke.]	Pontycymmer ..	Coppée.
Rhymney Iron Co. ..	Rhymney	Coppée.
Tredegar Iron and Coal Co.	Tredegar	Coppée.
Welsh Navigation Co. .	Coedely	Coppée by-product.*

* In construction.

Output.

Owing to the number of additional coking plants that have been built lately, the total output of coke from the coalfield is now largely in excess of what it was ten or even five years ago. The figures for 1910 were:—

	Tons
Glamorgan ‖	792,144
Monmouth	575,473
Total for South Wales	1,367,617
Total for United Kingdom	11,925,115

‖ Including Denbigh, where there are 61 Semet-Solvay ovens.

The chief market for South Wales coke is, of course, the ironworks of the district. The large ironworks make coke for their own consumption in addition to what they purchase. A large and increasing amount is sent to the Midlands—to Staffordshire and the Birmingham district—and although on account of railway rates it cannot compete with Durham coke in the Northern coalfield, there are regular consumers of South Wales coke beyond the Scottish border. The effect of increased production is already shown in the exports, and it is probable that South Wales will take a much more important position as a coke exporter in the future. Export of coke began in 1856 with 5,000 tons; it now amounts to about 160,000 tons per annum, the greater part going to Spain (Huelva), the Argentine and Uraguay, the Eastern Mediterranean, and Cape Colony.

Character of Coke.

In conclusion, the analyses of a number of Welsh cokes are given. Commercially, they are classified as "Special Foundry," "Foundry," and "Furnace"

cokes. These correspond roughly to the following types:—

Class of Coke.	Volatile matter.	Ash.	Sulphur.	Phosphorus.	Fixed Carbon.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Special foundry ..	0.5	5.8	0.6	0.02	93.7
Foundry	0.8	7.5	0.8	0.02	91.7
Furnace	0.8	10.0	1.1	0.02	89.2

The best Welsh coke is unsurpassed in physical condition. Its pores are small and finely divided, and in purity and freedom from deleterious substances it compares favourably with other cokes; it has proved itself eminently suited for foundry work.

Coke.	Moisture, per cent.	Ash per cent.	Sulphur per cent.	Phosphorus per cent.	Authority.	Remarks.
Blaenavon	4.0	9.5	0.81	0.020		Average at ovens.
„	2.0	7.8	0.75	0.019	G. Foster Martin	Average for 12 months at furnaces.
Cwmbran	4.0	11.0	1.5	0.020	W. Jenkins ..	Average at blast furnaces.
Ebbw Vale	5.0	7.5	0.7	0.020	Salwey Browne ..	Average at oven.
Elder's	1.7	9.3	0.81	—		Sampled at foundry.
„	—	8.0	0.75	—		Approximate average.
Ffaldau	4.0	5.7	0.58	0.016	W. Jenkins ..	Average at blast furnaces.
„	—	4.98	0.69	0.016	F. G. Treharne ..	
Great Western	—	5.97	0.77	0.022	„ ..	
„ „	3.0	6.5	0.80	0.020	T. G. Watts ..	Average for 3 months at ovens
„ „	1.0	5.8	0.65	0.017	„ „ ..	Best quality.
„ „	4.0	7.6	0.78	0.024	W. Jenkins ..	Average at blast furnaces.
Lewis-Merthyr	1.0	7.5	0.68	0.023	E. C. Evans ..	Average at ovens.
Llanbrabach	—	11.0	1.0	—		Approximate average.
Newport Abercarn ..	4.0	10.0	1.1	0.005	W. Jenkins ..	Average at blast furnaces.
„	—	7.76	0.63	—	E. Riley	
Norths	—	5.0	0.55	—	J. Boyd Harvey ..	Average at ovens.
„ Maesteg	4.0	5.6	0.62	0.017	W. Jenkins ..	Average at blast furnaces.
„ Tondu	4.0	6.0	0.68	0.019	„	„ „ „
Powell Duffryn	0.0	9.0	1.10	0.040	„	„ „ „
„ „	4.0	7.84	0.91	—	E. M. Hann ..	Average at ovens. „
Rhymney	5.0	10.5	1.25	0.047	W. Jenkins ..	Average at blast furnaces.
Tredegar	6.0	8.0	0.90	0.040	„	„ „ „

The Glamorgan Coal Co. (makers of Hood's and Glamorgan cokes) are completely reorganising their coking department, and constructing new plant: analysis of these cokes are therefore omitted.

Discussion.

Mr. H. Pilkington (Chesterfield) in opening the discussion, said that as one much interested in coke-making, he was interested in the Paper, although it was with the coke of South Yorkshire and North Derbyshire that he had to do. He knew the disadvantage of high moisture and imperfect coking. The by-product system had necessarily not gone so well in South Wales as in Yorkshire, because of the extremely low percentage of volatile matter, but he could not understand why greater developments did not take place, notwithstanding the lesser yield of by-products. Mr. Greaves had referred to the large quantity of moisture in coke and to the quality having deteriorated much since the strike. There was not the slightest doubt that the reason of that deterioration was that the producers had conveniently forgotten the proper time requisite for coking and had placed too great reliance upon the hose pipe. In the old system of beehive coking they got a dry coke, perfectly burned, and did not depend upon or fear the heavens as to water. He was very glad to notice the mention of the apparatus for quenching connected with Darby. The quality of by-product coke depended upon it being properly burnt, and sufficient time being given, with care in the use of water. References had been made to the sulphur in the cupola, which he cordially endorsed. There was no doubt that the coke used in the cupola should contain as little sulphur as possible, because it had a very deteriorating effect upon the casting, far more injurious than many managers and foremen imagined. He would like to ask one question with regard to the remark dealing with the ovens at Bargoed. The author said: "It is purified in the ordinary by-product plant and then deprived of sulphur, which is converted into sulphuric acid for the manufacture of sulphate of ammonia." He (Mr. Pilkington) would like to know whether that was correct or whether there was not some error, whether it was true that the sulphur was obtained from the gas itself and converted into sulphate of ammonia, as it could not provide sufficient acid. In the district he represented, they believed that the by-product oven had come entirely to the exclusion of beehive coke. He was quite sure that the latter types of ovens made coke quite as good as beehive ovens, but it was quite possible to produce "Coalite" in by-product coking ovens for the use of blast furnaces. That showed the range between retort baking and real coking. It was all a question of manipulation and care. Although he had used Welsh coke, that use had not happened to be in a foundry cupola.

Mr. F. J. Cook (Birmingham) said he felt personally indebted to Mr. Greaves, because he had given, quite without prejudice, just what the foundryman wanted to know, namely, the qualities of the various cokes made in the district. He thought that had been done quite fairly, and the information given was of great value. He was rather surprised to hear the statement that since the strike coke had inclined to deteriorate. Personally, he anticipated it was very likely it would, and he was very careful to have a close analysis made of the cokes which immediately followed the strike. But he was very pleased to say, as a user of South Wales coke, that they had not gone off in quality, but had come up in every respect to specification. He had had, however, a great deal of trouble immediately before the strike. Probably the coke vendors were working off their old banks, in the same way as the coal was worked off. He was bound to bear his testimony to the good quality of the coke turned out in the district.

Mr. Fox-Allin (Birmingham) said that with regard to the recovery of by-products in South Wales, that was more a question of the nitrogen content of the coal than anything else. He noticed in the plants illustrated that there was no provision for the recovery of benzol. He did not know what it was worth per gallon, but he presumed it hardly paid for recovery. Perhaps Mr. Greaves would give them some information on that subject. Mr. Pilkington had raised the question of beehive coke as opposed to by-product oven coke. That was mainly a commercial consideration; at any rate, if not in Wales it was in other parts of the country. To take Yorkshire for an example, the best coking seams in that

coalfield were very largely being worked out, and it became necessary to mix the coal. That could not be done satisfactorily in a beehive oven, because if it were done, two or even three qualities of coke were got out of one oven, from one coking. In many respects it was better to make a medium or even inferior coke of a uniform quality rather than make three qualities. In the beehive oven the coal was put in as mined, and that did not allow the small to be used up so satisfactorily as under the retort system. Then, again, beehive coking was very destructive, so that in nine times out of ten they not only wasted the valuable by-products in the production of the coke, but the whole of the gases went to waste. Primarily, it was the possibilities in "marrying" two or three qualities of fuel and getting an absolutely uniform coke, besides recovering the by-products, which led to the use of the modern ovens. A very important point was emphasised by Mr. Greaves in regard to the quenching of the coke. It was possible to mention half a dozen coke-oven people, all of whom would give a uniformly burnt fuel. But in quenching it was an essential feature to ensure that silvery appearance which appealed so much to the trade. The improved methods of quenching had greatly reduced the percentage of moisture.

Mr. S. A. Gimson (Leicester) said he would like to ask the author a question with regard to retorts. He had had no experience of coke-making with gas as a by-product; but he had had considerable experience of gas-making in a large town where coke was a by-product. Feeling had been running very strongly in the direction of vertical retorts, with continuous action, as compared with vertical retorts having intermittent action, or the old horizontal retorts. In the old intermittent retorts the coal was left in the full time necessary to extract the gas; then the coke was cleared out and the retorts filled again with coal. In the new continuous retorts the coal was constantly fed in at the top and the coke continuously passing out at the bottom, the retorts being so designed that the time occupied from the coal entering at the top and passing out at the bottom as coke was sufficient to extract the gas. It was a continuous process of coal going in and coke coming out. He wondered whether that had ever been considered in connection with coking. They found in the case of by-product coke, they got a very considerable gain, both in quantity and quality, of gas, and in quality of coke, by that system as compared with the use of the old horizontal retorts. He wondered whether the idea of continuous vertical ovens had ever been tried in connection with the making of Welsh coke.

Mr. Greaves, replying to the question as to the sulphate obtained at Bargoed, said that was obtained indirectly from the gas. It was absorbed in ferric oxide, which was afterwards burned, giving sulphur dioxide, used for the manufacture of sulphuric acid. In regard to the last point raised by Mr. Gimson, he did not think that any continuous ovens of the description suggested had been in use. He was afraid they would give a certain character to the coke which would render it liable to be not so dense and very friable. The yield of by-products in South Wales coal was very small. There was a fair amount of nitrogen in the coal. If the sulphate of ammonia yield were relatively as low as the yield of tar, then the future of the by-product ovens would be very much more risky than it was at present. They would notice from the table given in the Paper that the sulphate yield was not very much below the yield for the average of the United Kingdom, while the tar yield was only about one-third to one-half. The point about the quenching was very important, and he had mentioned that previous to the introduction of modern systems one great objection to the coke made in the kilns was that it burnt away very rapidly Another great objection was that they had to drench the coke with water in such a way that it took up 20 per cent. of the moisture. Formerly, by quenching in the ovens, and now by use of certain appliances, that had been very greatly reduced.

Impurities in "Tough-Pitch" Copper.*

By Frederick Johnson, M.Sc., A.I.M.M. (Head of Metallurgical Department, Swansea Technical College).

In continuation of a series of experiments carried out with a view to ascertaining and placing on record the varied influences of traces of impurities on the useful properties of copper, the author now presents in this Paper the results of experiments which, in the main, have been directed toward the determination of the influence of antimony on "tough-pitch" copper. Assuming that copper containing impurities can be successfully rolled hot, it remains to show whether such copper will have mechanical properties inferior, equal, or superior to those of pure copper, and to show also, if possible, the structural condition of those impurities. The author's conclusions are as follows:—

(1) Antimony up to 0.5 per cent. has no detrimental influence on the hot-forging qualities of "tough-pitch" copper free from other impurities. It is even possible successfully to forge copper containing 1 per cent. antimony if sufficient oxygen be present.

(2) In copper which has been "overpoled," antimony tends to mitigate the phenomenon of "spewing" during solidification.

(3) "Tough-pitch" arsenical copper (0.4 per cent. arsenic) is slightly hardened for hot-rolling by the presence of antimony (0.2 per cent.), but, otherwise, its mechanical properties are slightly improved.

(4) The mechanical properties of "tough-pitch" pure copper after rolling and annealing are but little altered by small additions of antimony. The tensile strength is slightly raised, and the elongation is lowered. The slight gain in toughness is probably traceable to the greater soundness of the cast ingot.

(5) With regard to the structural condition of antimony in "tough-pitch" copper, it exists in two forms:—(*a*) Partly in solid solution (probably as dissolved Cu_3Sb).; (*b*) partly as an insoluble compound with oxygen (slate-coloured "oxidules"). Oxygen in excess exists as cuprous oxide (light-blue "oxidules"). The latter, together with the antimonial "oxidules," form a ternary eutectic with the solid solution.

(6) The addition of lead to pure copper or arsenical copper causes the surface of a "tough-pitch" ingot to sink during solidification. Further poling with the object of obtaining a level surface is attended by the risk of rendering the metal "red-short." Like antimony and arsenic, lead tends to check "spewing."

(7) The mechanical properties of arsenical copper (0.4 per cent. arsenic) at normal temperature are little affected by the addition of lead (0.2 per cent.).

(8) The addition of tin (0.2 per cent.) to "tough-pitch" arsenical copper is attended by an increase in hardness during hot and cold rolling, and an increase in tensile strength. The elongation is correspondingly lowered, but the toughness is unimpaired.

* Abstract of Paper presented before the Institute of Metals.

New Process for Casting Ingots.*

By J. Corbiau.

The difficulties experienced by small rolling mills in the way of obtaining their raw materials (ingots, blooms, and billets) on advantageous terms, have led many of them to consider the installation of an open-hearth steel plant capable of supplying their needs in this respect. In carrying out this idea, an inconvenience is experienced by those plants which are not equipped with large cogging mills, in that they would have to cast a large number of ingots. For instance, with a 15-ton open-hearth furnace, in order to get ingots weighing about 1½ cwts. each, nearly 200 ingots would have to be cast from a charge—say four groups of 48 each, or six groups of 32—and as the members of each group are connected together by runners, all these latter require to be broken off, at considerable expenditure of time and trouble. Moreover, the ingot moulds soon wear, and cause difficulties in stripping, so that, with all these delays, it is impossible to clear the casting shop by the time the next charge of the furnace is ready for pouring.

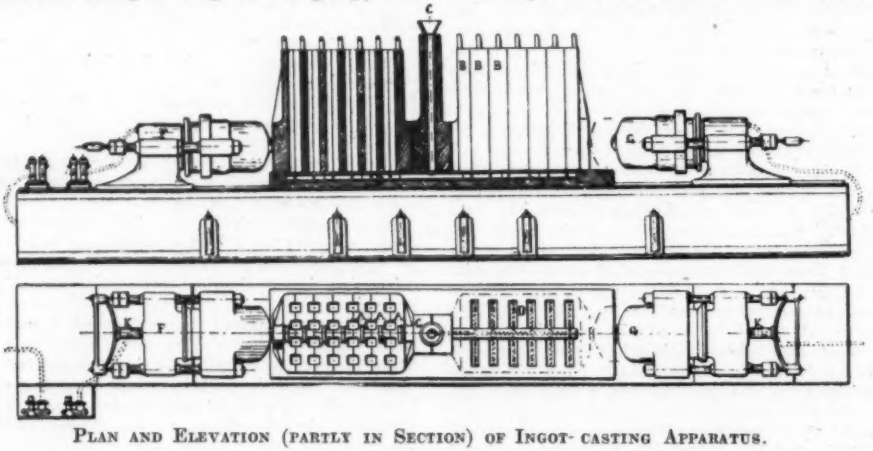
With a view to remedying these drawbacks, a Belgian engineer, M. Defays-Lanser, Brussels, has introduced a device for shearing off at one stroke all the runners connecting the ingots of a group, and also for stripping the ingots with celerity and ease. Instead of the simple, duplex or quadruplex moulds generally used for casting small ingots, the moulds are formed of plates, fitted with recesses which, when placed in juxtaposition, form cells into which the molten metal is poured. The requisite pressure for tightening these plates up together is furnished by a ram, operated by hydraulic, steam, compressed-air or other form of power.

A sectional elevation and plan of one form of this device are shown in the annexed drawing, in which A A A, etc., and B B B, etc., are two series of plates which, when placed in contact, form the ingot moulds; C is the main pouring head for the mother ingot; D are brick passages through which the metal flows into the moulds; F and G are two hydraulic cylinders working in opposite directions and compressing all the moulds between them; whilst K K represent two small hydraulic plungers for returning the plungers of F G to their original position.

The device works very simply. Previous to pouring, the plunger G is alone in operation, its position being indicated by the dotted line. As soon as the metal has been poured and sufficient time has elapsed for the runners to become solid, the plunger G is drawn back by means of the small plunger K, and pressure is applied behind the plunger F, which drives before it the whole battery of moulds, thus shearing off the runners flush with the base of the moulds. On relieving the pressure in F, the mould plates are dismounted and the ingots taken away.

The system presents numerous advantages, the rapidity with which the moulds can be dismounted enabling the plant to keep pace with the working of the steel furnace, and also allowing the ingots to be sent in a hot state to the rolling mill, thus reducing the cost of reheating. Another advantage is that the cast-steel mould plates are far stronger than cast iron; and again, the moulds can be more easily examined, repaired and kept in good condition, thus increasing their length of service.

The pecuniary advantage is also considerable. Take the case of a 15- to 16-ton open-hearth furnace, and ingots measuring 4¾ in. square at the base and 32 in. high, the weight being about 1½ cwts.; then four groups of moulds (48 in each) will be required to take a 15-ton charge. Working 250 days per annum, the total output of such a furnace will be 15,000 tons of ingots. With the new casting machine the cost of refractory materials is reduced to a minimum, the ingots being situated as closely together as possible, whereas in the ordinary way about 1 cwt. of bricks will be needed for each group, a consumption of 208 tons, costing about £250 per annum.



Plan and Elevation (partly in Section) of Ingot-casting Apparatus.

Secondly, for producing a given weight of ingots, the weight of the mould plates is only three-fifths that of the ordinary moulds, so that if we take the wear of the moulds as 33 lbs. per ton of small ingots produced, the corresponding figure with the casting machine will be only 20 lbs., or 135 tons as compared with 225 tons per annum. Although the cost per ton of these mould plates is higher than that of ordinary moulds—about 25 per cent. more—owing to the greater care required in their production so as to obtain tight joints at the edges, nevertheless, in view of the smaller consumption, the plates give a saving of nearly £110 per annum. At the same time, the moulds being closer together in the machine, the waste in runners is smaller by about 1½ cwts. in each case, or 6 cwts. per furnace charge, equivalent to 312 tons of ingots per annum, the gain on the difference of value between ingots and scrap (80s. and 48s. respectively) representing practically £500 a year. The machine can be worked by two men less than are

* "La Metallurgie."

usually needed for breaking off the runners; and this gives a saving of £200 a year.

The ingots are of uniform section from top to base, like blooms, instead of being in the shape of a truncated cone, as in the ordinary system. This uniform section is advantageous, enabling the head end of the ingot to be worked equally with the rest while at a welding heat, which cannot be done with ingots of the usual shape. The new system is regarded as specially adapted for casting cylindrical ingots for weldless tubes, and also for wire drawing, in which latter process the ordinary ingots always give an undue proportion of waste. For tinplate bars it should also be suitable, as with prismatic ingots, the difficulty of rolling the bars out to uniform thickness could be avoided. In one Belgian mill where the new system is in operation, the output of finished bars has been increased by 370 tons, worth 116s. per ton, the profit resulting from the difference between this and the scrap value of the metal being £1,036. Taking all the economies mentioned above, the total saving afforded by the machine amounts to about £2,090, or 2s. 9d. per ton of metal produced.

Where, as is sometimes the case, moulds with up to four compartments are used for casting small ingots, there is still a saving by the employment of the casting machine, equivalent to about 1s. 10d. per ton of steel, compared with which the small outlay for motive power (approximately 1d. per ton) is insignificant.

The only practical drawback to the system is the chance of fins being formed at the edges of the ingots and requiring great care in removal, since otherwise these defects may find their way into the finished products. This difficulty has been overcome to a certain extent by using high-grade cast iron for the mould plates and by taking great care to have the joints tight. With cast iron, however good, there is, nevertheless, always the risk of the moulds being burned at the joints by the hot steel—in which case tightening the joints is no remedy. However, a way out seems to be indicated by the use of cast-steel plates, this class of metal having been successfully used for ordinary ingot moulds in several large German steel works.

Tests of White Metals.*

By N. Pecoraro (Spezia Arsenal).

Among the alloys which are utilised in engine construction, the so-called anti-friction alloys claim a particular importance. Most of these alloys contain as chief constituent tin which is mixed with antimony, copper, sometimes with mercury and with small quantities of lead. Not rarely we find alloys whose chief constituent is lead, and finally in isolated cases such which largely consist of zinc.

When making a choice of an anti-friction metal, we have to regard the specific stresses to which it will be exposed, the speed of the surfaces under contact, the manner of lubrication, the more or less great likelihood of shocks, etc. We have further to consider the suitability of the material for diminishing friction, its easy applicability, the capacity for adapting itself to diverse shapes—the latter because the metal must fill the journal bearing—the resistance to wear, the expense, etc. Such a selection can only be made on the strength of the results of experiments which must not only be very numerous, but which are also, from their very nature, very difficult to conduct. The performance of these experiments requires very expensive machines with which not every workshop is suitably provided. For this reason the choice of the quality of a white metal best suited for a particular purpose is often taken merely at the hand of experience, which has sometimes caused disappointments in subsequent experiments.

As a result of his experiments the author draws the following conclusions :—

(1) The temperature at which an anti-friction metal is fused may exercise an important influence upon the behaviour of the metal with regard to the coefficient of friction which would under otherwise equal conditions become apparent under application. In order that an anti-friction alloy may in practice give constant results under the same conditions, it should not only be prepared always by the same method, but it is also necessary that its fusion takes place at the temperature at which the alloy shows the most favourable behaviour. It need not be mentioned that this holds not only for practical application, but also for any preparation of specimens for laboratory tests.

(2) The hammering to which anti-friction metals are frequently submitted after having been poured into the bearings has, as a rule, an influence upon the friction which is not unimportant; in most cases this influence is not favourable.

(3) Of the acceptance tests of white metals, the compression tests appear suitable for arriving at an estimate as to how far the respective metal will be able to satisfy the conditions of compression without undergoing any practically inadmissible deformation.

(4) Abrasion tests appear always most desirable, since the resistance to abrasion is an important characteristic of anti-friction alloys. These tests are, however, neither easily conducted, nor can they rapidly be carried out. It would therefore be advantageous to substitute for them some simple experiments which would likewise enable us to make a comparison between different alloys as regards their resistance to abrasion. The hardness test by the Brinell method constitutes such an expedient. Further experiments to elucidate this matter more fully would be desirable.

(5) The determination of the hardness number of anti-friction alloys of equal chemical compositions may perhaps supply us with the possibility of establishing a comparison in broad features between the different alloys as to their suitability for diminishing friction. If this should be confirmed, the exact determination of the average hardness numbers of anti-friction alloys would acquire an extraordinary importance, because it would in many cases enable us to arrive at a quick estimate in place of the tedious, expensive and difficult friction test, for which moreover suitable arrangements are not always available.

(6) Apart from the impact tests which sometimes yield useful information with regard to the impact strength of anti-friction alloys, as well as from the compression and hardness tests which have already been discussed, useful information concerning the most important characteristics of those metals cannot be obtained from other mechanical tests (tensile and bending tests, etc.) to which such metals are occasionally submitted.

The author includes in his Paper results of a large number of tests of white metals. In the absence, however, of detailed analyses of the metals tested, these experiments have no great value.

* Abstract of Paper read before the International Association for Testing Materials.

CAST-IRON RAILWAY SLEEPERS.—As a result of preliminary tests which the South Indian Railway Company has carried out with a few cast-iron sleepers manufactured at the Barakur Iron Works of the Bengal Iron and Steel Company, Limited, the Railway Company has placed further trial orders with the Barakur Works on a more extended scale—for about 100 tons of broad-gauge and 100 tons of metre-gauge cast-iron sleepers—to be tested at the place of manufacture.

Cardiff Convention of British Foundrymen's Association.

(*Continued from page* 543.)

In our last issue we reported at length the proceedings of the British Foundrymen's Association at Cardiff. The following are particulars of the places visited by the members at the conclusion of the sessions:—

University College.

University College, the meeting place of the Convention, is in the Cathays Park, a tract of land of

MR. R. WALLIS,

President of Newcastle Branch of the British Foundrymen's Association.

59 acres, in the centre of the city. The Park was bought by the Corporation for £159,323, from the late Marquess of Bute, and has been laid out in an attractive style. Other important buildings which have been erected in the Park are the City Hall and the Law Courts, and the offices of the Glamorgan County Council. Plans have also been adopted for the erection in the Park of the Welsh National Museum and Art Gallery, at a cost of over £250,000, and a site has been granted for offices for the Central Welsh Board. A number of fine statues adorn the Park, which also contains a modern circle of Druidic Stones, a reminiscence of the National Eistedfodd, held in Cardiff in 1899.

The College was incorporated by Royal Charter in 1884, having been opened in 1883 in buildings in Newport Road, formerly the Infirmary. It is interesting to note that the first University in the kingdom was established in the neighbourhood of Cardiff in early Christian times, and the ruins of its buildings are still to be seen. The new buildings of University College, which are still incomplete, are being erected on a site of five acres, granted free by the Corporation. The foundation-stone was laid in 1905 by H.R.H. the Prince of Wales (now King George V.), who was then Chancellor of the University of Wales. The Arts section and Library were opened on October 14, 1909. This group of buildings when completed, will form an architectural feature of the city worthy to rank with the City Hall and Law Courts, in harmony with which they have been designed.

Since its opening, the College has made marvellous progress. The first faculties instituted were those of Arts and Science, with chairs in Greek, Latin, Philosophy, English, Mathematics, Physics, Chemistry, Biology, and Celtic, with lectures in French, German, and music, and demonstrations in physics and chemistry. Chairs in Engineering, Mining, and Geology were afterwards added, through the munificence of the Drapers' Company in London. A Medical School was founded at the College in 1894, and a fund has been raised for the establishment of a School of Mines.

The Dowlais Ironworks.

On the Tuesday afternoon the members of the Convention were favoured with an inspection of the Dowlais Works of Guest, Keen & Nettlefolds, Limited. Interest was added to this visit by the fact

MR. J. ELLIS,

Vice-President of London Branch of British Foundrymen's Association.

that the works were recently visited by the King and Queen, who witnessed some of the processes in operation. The firm, as is well known, has works and allied concerns in various other parts of the country. The Dowlais Works, originally the property of the Dowlais Iron Company, are situated at the East

Moors, Cardiff. Their erection was commenced in March, 1888, and two blast furnaces were blown in on February 4, 1891. The steel works and plate mills commenced operations on September 12, 1895. In 1900, a company was registered to acquire the business of the Dowlais Iron Company, and Messrs. Guest, & Company, of the Cradley Iron Works, Staffordshire, ironmasters and colliery owners, and that of the Patent Nut and Bolt Company, Limited, Smethwick. The business of Nettlefolds, Limited, Birmingham and Smethwick, manufacturers of screws, etc., was acquired in 1902, the Company then being registered as Guest, Keen & Nettlefolds, Limited, with an authorised capital of £3,000,000. Mr. Arthur Keen has throughout been Chairman of the amalgamated Company.

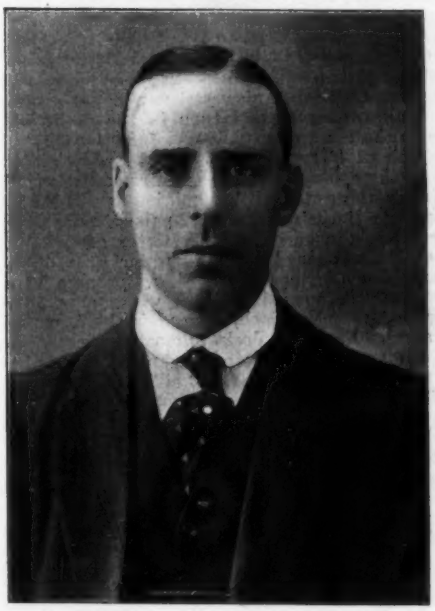
The manufactures of the Dowlais Works include Bessemer hematite pig-iron, Siemens open-hearth steel slabs and steel plates for boilers, steel plates for shipbuilding, girder work, etc. The first portion of the works visited was the blast-furnace plant, the approach to which is from the wharf. This plant consists of four blast furnaces, two of them 75 ft. high and two 85 ft. high, and all are fitted with the latest improvements in tuyeres and coolers. At the back of the furnaces are twelve hot-blast Cowper stoves, eleven of which are 68 ft. high, and one 85 ft. high. On the other side of the siding, which runs at the back of the furnace plant, are eighteen bunkers, which are used for the storing of coke, ore and limestone. The wagons on which the material is brought up to be deposited to the bunkers are raised by means of a water-balanced hoist to the top of the bunkers, and then run over a gantry. After unloading, they are lowered at the other end by a gravity drop. In front of the blast furnaces run the pig beds, which are fitted with travelling cranes covering the entire length, and with hydraulic pig breakers.

The four compound condensing blowing engines for the furnace plant are situated in an engine house 148 ft. long, 32 ft. wide, and 60 ft. high, directly facing the furnaces. The steam for these engines and other machines is produced by 21 Lancashire and four water-tube boilers, which are placed at the south end of the engine house. The boilers are heated with gas from the furnaces, and are fitted with economisers. At the back of the engine house are situated the pump house and electric generating station and the dry-blast plant on the Gayley system. In this pump house and electric generating station are placed the five hydraulic pumping engines for working the hydraulic plant in connection with the wharf, blast furnaces, steel works, mills, etc., also the electric generating plant, which consists of three 500-kw. direct-coupled engines and dynamos and one 250-kw. similar set. This plant supplies the current for power and lighting. There are about six miles of copper conductors about the works, 130 motors being in use for driving overhead cranes, fixed and portable winches, furnace-charging machines, live roller gearing, pumps and portable tools, etc.

The steel plant consists of a 180-ton Talbot furnace and six 40-ton Siemens open-hearth furnaces, which are equipped with one 40-ton and one 30-ton overhead electric cranes, and two Wellman-Seaver charging machines. The requisite gas is derived from 22 ordinary gas producers and one Talbot-Fraser producer, all of which are placed at the back of the smelting furnaces. After casting, the ingots are placed in three vertical gas furnaces which are situated between the smelting furnaces and the slab mill. This mill is worked by a horizontal high-pressure steam engine, cylinder 48 in. diameter, 30-in. stroke, and the mill is capable of rolling ingots up to 10 tons in weight. Between the slabbing mill and the plate mill is the radial hydraulic charging machine, by means of which the slabs are taken mechanically from the slabbing mill and placed in five reheating furnaces and thence conveyed as required by the same machine to the plate mill. The plate mill is worked by a high-pressure engine with a pair of cylinders 54 in. diameter, 50-in. stroke, and is capable of rolling 2,100 tons per week. From the mill the plates are conveyed to the shears, and from thence to the loading bank.

When the foundrymen visited the works, only the blast furnaces and the small brass foundry were in operation, the steel works being idle, and several repairs to furnaces being in progress. Special interest, however, was taken in the testing department, where the products of the steel mills are carefully analysed and tested. The plant for freezing the blast-furnace air was also visited.

At the close of the visit a hearty vote of thanks was accorded to the directors of the Company for allowing the visit, Mr. Rees, the general manager, and Mr. Patterson being specially mentioned for their personal attention. This was proposed by the PRESIDENT and seconded by MR. LONGMUIR. The President acknowledged the care taken to fully explain the details of the various processes.



MR. R. T. MURPHY,

Secretary of London Branch of the British Foundrymen's Association.

MR. PATTERSON, in reply, said the duty had been a very pleasant one, and it was a pleasure to explain matters to visitors that showed so intelligent an interest in everything.

Cardiff Docks.

The great sight of Cardiff, from an industrial point of view, is the magnificent range of docks. Very appropriately, therefore, the concluding hours of the Foundrymen's stay in Cardiff were devoted to visiting the Bute Docks, and the docks and hydraulic houses at Penarth. The afternoon was spent in and around the Bute Docks.

The visitors could not fail to be impressed with the importance of Cardiff as a shipping centre, which importance is mainly due to the marvellous expansion of the South Wales coalfield, the annual output of which has risen since 1854 from 8,500,000 tons to considerably over 50,000,000 tons, its proportion to the aggregate output of the United Kingdom being increased during the same period from 13.1 per cent. to 19 per cent. Though Cardiff was the chief port for coal and iron of South Wales more than two centuries ago, when coal and iron for the mills was brought there on the backs of mules, its era as a great commercial city began with the opening of the canal in 1798.

The more modern phase of the port, however, dates from the opening of the West Bute Dock in 1839. The docks, formerly the property of the Marquess of Bute, have been since January 1, 1887, vested in a public company, formerly the Bute Docks Company, but now known as the Cardiff Railway Company. The managing-director is Sir William Thomas Lewis, Bart., K.C.V.O., who also is the chief administrator of the Bute Estate, with which he has been connected for over fifty years. Sir W. T. Lewis was succeeded as general manager of the Company, in February, 1910, by Mr. C. S. Denniss.

The water area of the Bute Docks, without reckoning the magnificent docks at Penarth and the port of Barry, is 163 acres. The latest and largest addition is that opened by King Edward VII. in July, 1907, and named, by His Majesty's desire, the Queen Alexandra Dock. Any vessel now afloat or likely to be built can enter and turn in the dock, which is nearly half a mile (2,550 ft.) in length, with a breadth of 800 to 1,000 ft., and a depth of 50 ft. below the coping level. The entrance lock is 800 ft. between the gates, with a minimum width of 90 ft. The Bute Docks number five, named, respectively :— West Dock, opened in 1839, water area 19½ acres; East Dock, opened in 1855, water area 46¼ acres; Roath Basin, opened in 1874, water area 12 acres; Roath Dock, opened in 1887, water area 33 acres; Queen Alexandra Dock, opened in 1907, water area 52 acres. Each new dock, to meet the increasing size of the vessels trading at the port, was built with increased width or depth at sill.

The machinery and appliances were examined with particular interest. The "Lewis-Hunter" patent coaling cranes, named after the inventors and patentees, Sir William Thomas Lewis, and the late engineer, Mr. C. L. Hunter, represent the latest and most approved type of machinery for handling coal cargoes. One crane will lift up to 23 tons of coal and deposit it so gently in the hold that there will be absolutely no breakage. The cranes travel along the quayside, and three or more can be used at one time over the hatchways of a single ship. Thus a cargo of ten thousand tons of coal can be loaded in 24 hours. It is possible also to be unloading a ship at one end and reloading at the other.

The visitors also had their attention called to the extensive range of warehouses, wharves, and cold-storage houses, which have been called into existence to deal with the large and still rapidly-growing import trade of Cardiff. The whole of the side of Queen Alexandra Dock, as well as the upper end, is devoted to the import and general export trade. Two large transport sheds have been erected at this dock, and provision has been made for the storage of pitwood, deals, etc. Hydraulic and electric cranes are provided for the discharge and loading of general cargoes, one being a 70-ton crane for dealing with heavy machinery. For the extensive cattle import trade from America, Canada, and other countries, there is a commodious wharf, having a depth at spring tides of 23 ft and at neap tides of 13 ft. The lair will hold 450 head of cattle, and adjoining it is a completely fitted slaughter-house. In the vicinity of the docks, 1,000 acres of land have been set apart for leasing for the erection of factories.

With such an immense shipping trade Cardiff has necessarily had to make more and more provision for ship-repairing. The dry docks and repairing yards, therefore, form an important feature, and the facilities provided are so excellent that a large trade in repairing and refitting outside the natural requirements of the port has been attracted, vessels coming long distances to Cardiff specially for repairs.

Penarth Harbour and Docks.

Those of the party whose interest in dockland was sufficient to induce them to join in the evening visit to Penarth, about four miles south of the city, received a still deeper impression of the resources and importance of Cardiff as a port. Penarth, which a little more than thirty years ago, was an unimportant village, has since been thriving upon the overflow of the Cardiff shipping trade, due to the increasing demand for the steam coal and other exports of South Wales. The trading possibilities of the harbour at the mouth of the River Ely, however, received some recognition more than half a century ago. In 1856 a company was formed to construct a dock at Penarth, with railway connection to the Taff Vale Company's system. The harbour was opened in 1859, and the dock was opened in 1868, the dock and harbour in the meantime having been leased in perpetuity to the Taff Vale Railway Company. The harbour has a length along the centre of the river of 1,300 ft., the frontage to the Cardiff side being 12,000 ft. and the Penarth side 3,000 ft. The total water area of the two reaches forming the harbour is about 81 acres, and provision has been made for ten staiths for the shipment of coal.

In 1881 the commerce of Penarth had become so great that further provision had to be made, and in 1884 a new dock was opened. This has a length of 2,900 ft., a width of 370 ft., and a water area of 23 acres. The lock has a length of 270 ft. and a width of 60 ft., and the sea gate has a depth of water of 35 ft. at spring tides and 26 ft. at neap. As the lock is tidal, it is open at high-water from sea to dock, so that ships avoid the delay caused at other docks by locking.

There are 15 coal staiths in the dock and six in the basin, including one berth of four and one of two movable staiths, each capable of loading 400 tons per hour. The largest steamships can be loaded here with the greatest possible dispatch, and the loading machinery is provided with patent anti-breaking appliances.

The visit included an inspection of the hydraulic houses. Hydraulic power is very largely used in the port. There are a number of hydraulic cranes for the discharge of ballast and iron ore. Hydraulic power is also used for opening and shutting the dock gates, and for a number of other purposes. Large centrifugal pumps are employed at the docks for increasing the depth of water during neap tides. There are two large river wharves, each 600 ft. long, fitted with hydraulic cranes for the quick dispatch of vessels laden with iron ore.

Penarth is not solely a coal port. It has a large import trade, consisting of pulp for paper-making, pit wood, iron ore, and general merchandise. In 1908 its imports amounted to 186,723 tons. Its exports in that year comprised, coal 4,267,585 tons, and general merchandise 3,607 tons. In another sense Penarth is an important adjunct to Cardiff. It is the favourite residential suburb for the shipowners, coalowners, and merchants of the city, and is also advertising its attractiveness as a watering place.

Foundry Plant and Equipment.

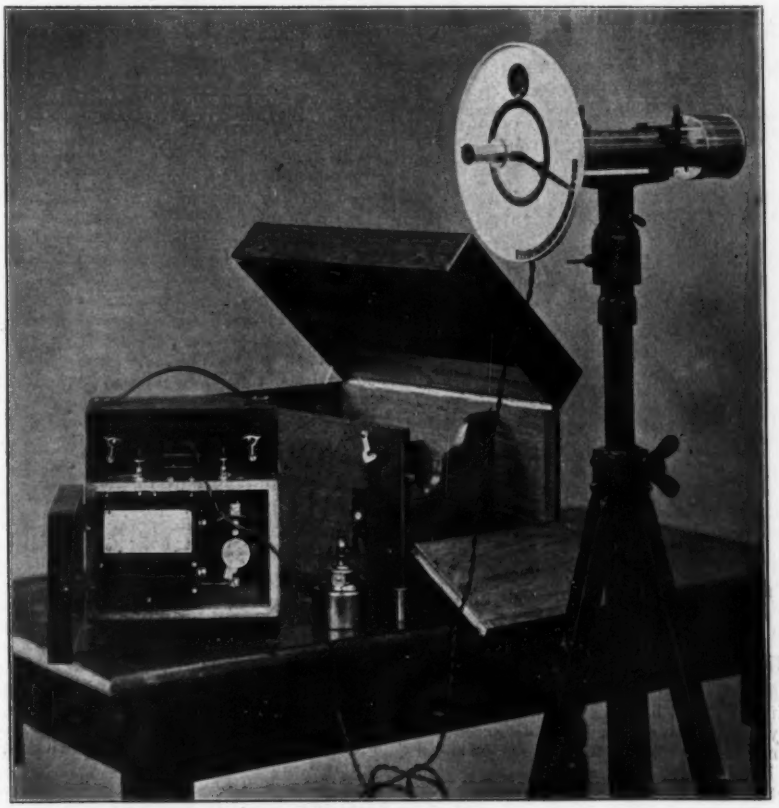
The Leskole Optical Pyrometer.

Pyrometers are now everywhere used, those based upon thermo-electric principles or the measurement of electric resistance being universally known. But there are many instances where it is not practicable to employ either of these well-known types. This may be because the temperatures to be dealt with are beyond the limits of thermo-couples (1,600 deg. C.), because chemical influences would destroy the protecting armour of the elements, or the usual couples cannot be brought into contact with the material to be tested; or, lastly, because instantaneous observations are necessary of moving masses of material in a solid or liquid state.

For all these purposes a very practical instrument is the optical pyrometer, which utilises the relationship between the intensity of the light rays emitted by heated bodies and their temperature. By pointing this device at the object under observation, anyone is able to read on a scale its temperature. Such an instrument is of value in iron and steel works, foundries, etc.

To judge the temperature of a glowing body by its colour is the oldest known method of heat measurement, and it is not surprising, therefore, that many able minds should have been occupied in the task of finding a scientific basis for this undoubted relationship between light intensity and temperature. This was greatly aided by the researches of Professors Paschen and Wien, who have established a formula by means of which very accurate results are being obtained in optical pyrometers.

From delicate and complicated laboratory instruments, more robust forms for general use have gradually been evolved, and amongst these is the Leskole optical pyrometer, brought out by the Leskole Company, Limited, of Palace Works, Enfield, which represents the very latest practice, and combines many important improvements not to be found in any other similar apparatus. In outward appearance this pyrometer resembles a telescope and it is used in a like manner. When focussed upon the object under observation, its light rays pass through a fine slit in front, are polarised, collected and concentrated by various prisms, so that they illuminate one-half of a circular field. The other half of this field is lighted by a small electric lamp, fitted in the front part of the instrument and having its rays similarly directed. The ocular, through which the observer views these two fields, is provided with a Nicol prism, which can be turned by hand and enables the user to adjust the two halves of the lighted circle in the pyrometer to equal intensity. As the quality of the light of the electric lamp is under control and therefore known, a comparison of



LESKOLE PYROMETER.

its intensity with that of the object under observation enables an accurate determination of the temperature of the latter by means of the formula above-mentioned. In the Leskole, the ocular is provided with a pointer, which indicates this temperature on a scale fixed to a large disc.

It will be seen that the accuracy of the readings depends upon the light of the electric lamp remaining constant. As this is subject to variation both on account of wear and the condition of the 4-volt battery supplying the current, the instrument is calibrated from time to time with the aid of a special test lamp, of known candle-power, which is supplied with each set. The battery is fitted in an oak carrying case, and to this is attached a precision milli-ammeter and a regulating rheostat. By noting the indication of the ammeter when the test light is at equal intensity with the electric lamp in the pyrometer, test conditions may then be maintained by adjusting the regulating rheostat as required, to obtain a constant supply of current to the lamp.

The Leskole optical pyrometer is made in two patterns. The large size is supplied with one or a number of centigrade scales up to 7,000 deg. C. The small instrument is specially designed for comparatively low readings for taking casting temperatures in foundries and observations in connection with the hardening of large pieces, etc. It is fitted with scales up to 1,200 or 1,300 deg. C., is small, light, and very sensitive, allowing of instantaneous temperature determinations of flowing or moving masses. Both types are supplied in oak carrying cases, and can be used either in the hand, on a stand, or on a wall bracket.

The following special advantages are claimed for this instrument:—It is enclosed by a strong, light and rigid steel casing, which protects all parts, including the electric lamp and its connections, against dust, excessive heat and damage through rough usage. The direct-reading temperature scale is fixed to a large disc which guards the free eye of the observer completely against dazzling or blinding, so detrimental to the accuracy of the readings. The hot object is focussed instantly through a special red sight in the large disc. To replace the lamp when worn out, it is only necessary to unscrew the dust cap in front. A battery of only 4 volts is used, and forms with the ammeter and regulator one compact case, easily carried.

The Denison-Korte Briquetting Machine for Metal Borings.

The briquetting of metal borings for remelting has, during recent years, received considerable attention in Germany, and several plants have been designed to deal, on a large scale, with this class of scrap material. But the conditions under which the briquetting industry has developed, at any rate in some parts of Germany, are different to those obtaining in this country. In places like Berlin, Chemnitz, and others, the engineering works producing borings are separated by considerable distances from the iron works which purchase the borings, and the practice obtained, until lately, of selling the borings to chemical works for whatever they would fetch. The conditions for establishing large central briquetting plants were, therefore, more favourable than in this country, where the engineering works are frequently situated close to iron-smelting works, and the borings accordingly are readily disposed of.

Many works which produce large quantities of borings, however, object to sending this scrap material out of their works, and this consideration, coupled with the fact that the German makers of briquetting machinery have declined or neglected to supply small plants suitable for engineering works, has led to the development of the plant illustrated herewith. The apparatus, known as the Denison-Korte briquetting machine, was designed by Mr. Christian Korte, and is now being made solely by Messrs. Samuel Denison & Son, Limited, of Hunslet Foundry, Leeds, who hold the patents jointly with Mr. Korte.

The chief aim in designing the machine has been to combine compactness with simplicity of construction and economy in power consumption. The machine is provided with a powerful set of high-pressure hydraulic pumps connected to the substantial bottom casting of the press, which supports, by means of two strong steel pillars, the press head containing the main ram and the cylinder which forces the briquette from its pocket in the press table. The press table revolves round one of the press pillars, and is fitted with three pockets, one of which is always situated underneath the filling apparatus, a second one underneath the main pressing ram, and the third one underneath the knocking-out ram. The actions of feeding the briquetting material into the pocket in the table, pressing the briquette and forcing the one made last on to a travelling device, take place simultaneously and continuously, the table revolving for one-third of a revolution after each pressing operation.

To ensure smooth and rapid working of the press a hydro-pneumatic shock absorber is provided. The machine works entirely automatically; the valves are operated by hydraulic pressure only, and without the use of cams, cam plates, or such devices.

These plants are made in two sizes, the smaller of which, working with a reciprocating table, is capable of a yearly output of 150 to 250 tons of briquettes, whilst the larger one will turn out from 300 to 1,200 tons. To obtain the highest economy in working, an automatic feeding and preparing plant has been designed for the feeding of the borings to the machine; this renders the machine entirely independent of supervision and dispenses with labour.

An important feature in the design of this machine is that since each action is dependent on the previous action being completed, the pressing cannot begin before the table has been set exactly, the exhaust stroke cannot start before a certain predetermined pressure has been reached, and the turning of the table cannot begin before the exhaust stroke is finished. In case of wear or defect in any of the valves, the machine remains stationary, and the water passing through the pumps returns to the tank. Further, the machine is not worked by accumulators or intensifiers, but every operation is performed direct by the pumps. Consequently, the power consumed is only that required for each operation.

As regards the space occupied, a machine with 1,000 tons capacity per year requires floor space of 7 ft. by 6 ft. The machines can run without any supervision if the borings are charged mechanically into the filler of the machine; the attendance of a labourer for two or three hours per day for taking away the briquettes from the conveyor is quite sufficient. If the borings are not charged mechanically one labourer can easily serve a machine.

In connection with the suitability of these briquettes of borings for remelting, it is interesting to note the results of trials made by one of the leading locomotive works in this country. The melting charge was:—Summerlee No. 3, 30 per cent.; cylinder scrap, 35 per cent.; steel plate scrap, 5 per cent.; briquetted borings, 30 per cent. The analysis of this

mixture of iron was :—Si., 1.94 per cent.; Mn., 0.40 per cent.; S., 0.124 per cent.; P., 0.55 per cent.; C.C., 0.68 per cent.; G.C., 1.78 per cent. The mechanical tests obtained were as follows, on four bars, cast edgeways in dry-sand moulds, 3 ft. 6 in. by 2 in. by 1 in., supported on bearings 3 ft. apart :—

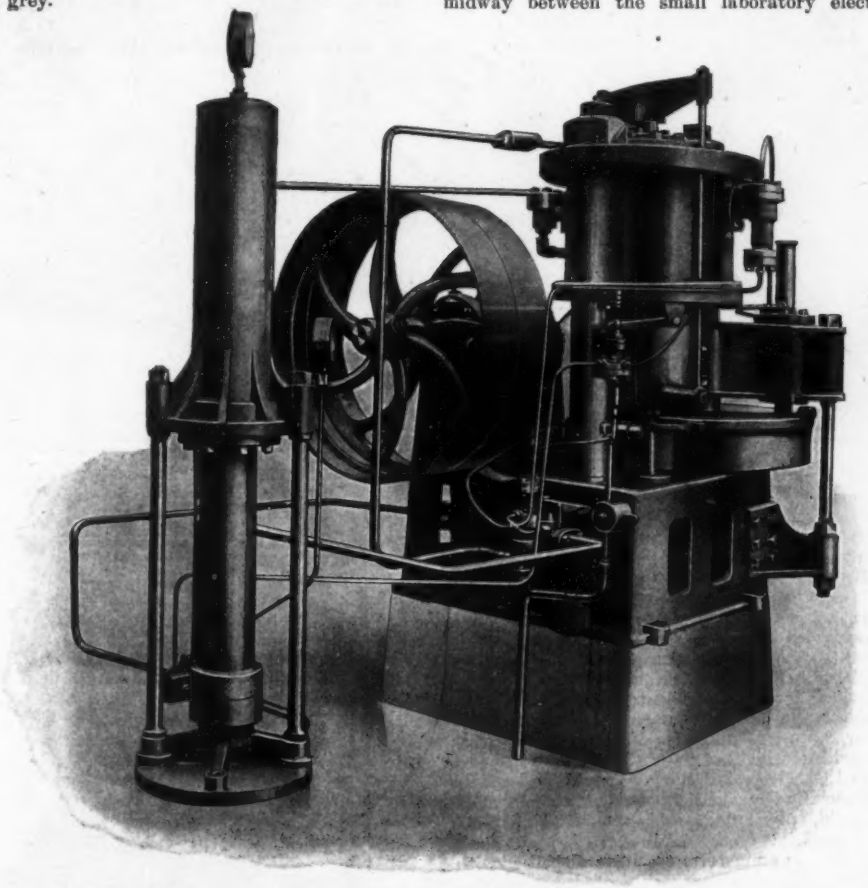
No.	Broke at. cwts.	Deflection. ins.
1	37.6	0.46
2	35.0	0.48
3	32.5	0.43
4	37.1	0.46

The fracture was very close and grey. Another bar, cast in a dry sand mould, 14 in. by 1 in. by 1 in., supported on bearings 12 in. apart, broke at 30 cwts., with a deflection of 0.18 in. The fracture was very close and grey.

As regards tensile tests, on two turned specimens cut from portions of the deflection bars after the deflection test was made, the results were :—

No.	Original dimensions ins.	Area per sq. in.	Breaking stress tons.	Tons. per sq. in.
1	0.798	0.5	6.45	12.9
2	0.785	0.484	6.00	12.4

As evidencing the value of briquetting in the case of non-ferrous metals may be quoted trials made by a firm of brass founders. Several trial meltings were made with briquettes from borings, and it was found that the losses in melting varied between 3 per cent. and 4½ per cent., which was considered very satisfactory. An hydraulic valve, intended to work with a pressure of more than one ton per square inch, was cast direct from the briquette, and the casting proved to be entirely satisfactory. From three aluminium briquettes, weighing in all 13 lbs., there were obtained 11 lbs. of good sound metal, the loss in melting amounting to only 2 lbs., or about 15.3 per cent. If the loose aluminium borings had been melted in the usual manner the loss would have amounted to at least 50 per cent.



THE DENISON-KORTE BRIQUETTING MACHINE FOR METAL BORINGS.

Electric Transformer Crucible Furnace.

To meet the demand which exists for a furnace midway between the small laboratory electric furnaces with a capacity measured in grammes and the large commercial electric furnaces, the A.E.G. Electric Company, Limited, of 133, Oxford Street, London, W., have developed a furnace type which has just been placed on the market under the name of "Transformer Crucible Furnace." With the exception of the smallest type, these furnaces are constructed in sizes for taking charges from 2 lbs. up to 220 lbs.

Each furnace unit is a combination of a transformer with a carbon crucible. The crucible itself forms the resister. The secondary terminals of the transformer are connected by flexible copper conductors with two water-cooled contacts gripping the crucible, so that the secondary current from the transformer

passes through the crucible and heats it. The carbon crucible is specially lined so as to prevent the carbon from having any effect on the charge and to prevent the current from passing through the charge.

cylinder for jarring and also for a guide for the large plunger for squeezing. The use of the small cylinder for jarring is said to result in a very marked reduction in the air consumption. Only two valves for

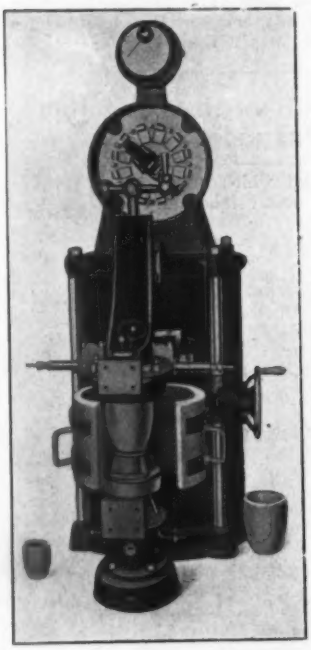


FIG. 1.—LABORATORY ELECTRIC CRUCIBLE FURNACE.

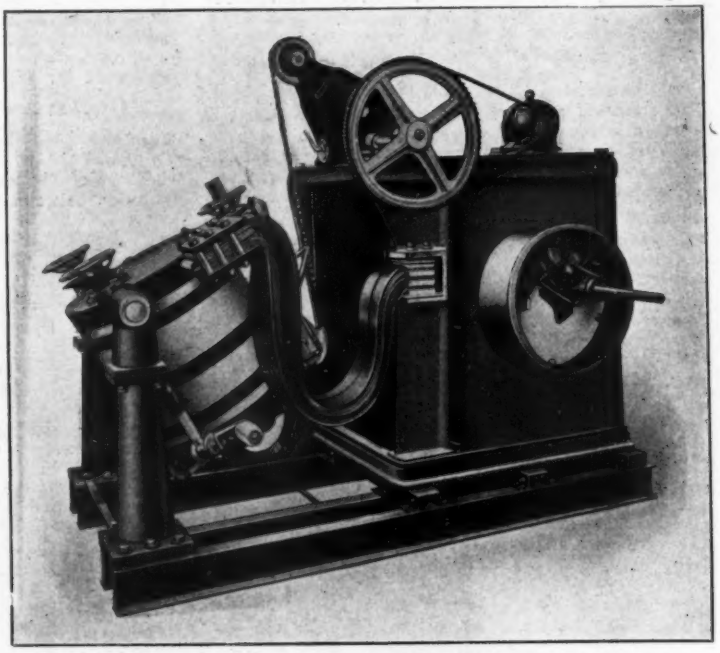


FIG. 2.—ELECTRIC TRANSFORMER CRUCIBLE FURNACE; FOR CURRENT UP TO 100-KW.

The transformer can be regulated so that up to twenty-four different rates of heating can be obtained. In addition to the regulating switch, an ammeter is provided for all except the smallest sizes.

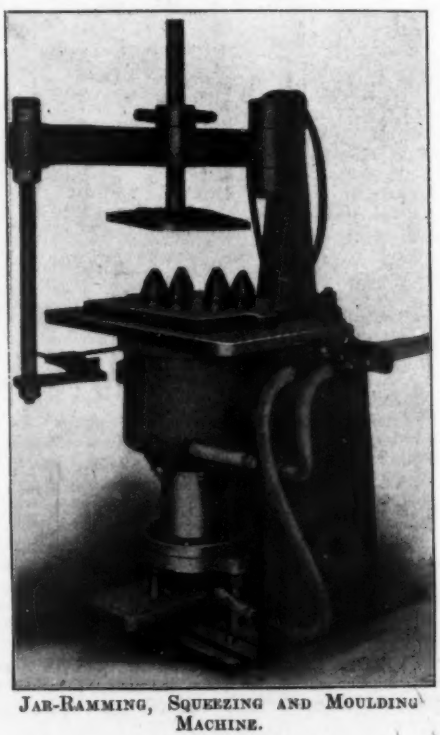
This furnace has already been introduced in Germany into various industries, especially in gun-metal, copper, bronze, and iron foundries, for melting precious metals, glass, and enamels, and in steel laboratories, chemical and other industrial establishments.

The smallest size of this furnace has been designed specially for the use of dentists; if required, tappings can be provided which enable the furnace to be operated at 1,000 deg., 1,400 deg., and 1,800 deg. It is used especially by dentists for melting enamel porcelain, gold, platinum, and the compounds employed for artificial teeth. All expensive auxiliary apparatus, such as ammeters, etc., are dispensed with in this type. The only part subjected to wear is the carbon crucible, which is cheap, and can be easily replaced by another one.

A New Combination Moulding Machine.

A new jar-ramming and squeezing and moulding machine, recently placed on the market by the U.S. Moulding Machine Company, Cleveland, Ohio, is shown herewith. The machine was designed by Mr. J. N. Battenfeld.

The special features of this machine are simplicity of construction and the absence of valves in the cylinder. The jarring cylinder at the bottom of the machine serves two purposes, since it acts as a



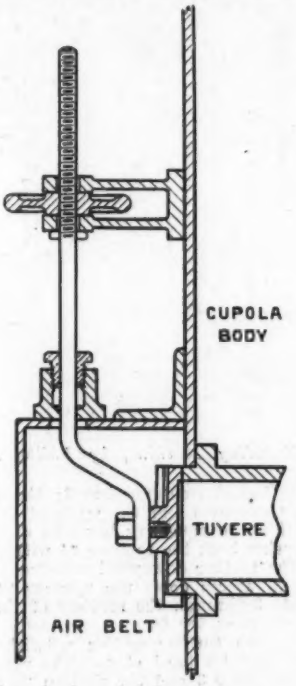
JAR-RAMMING, SQUEEZING AND MOULDING MACHINE.

controlling the supply of air are employed, these being the inlet valves for the jarring and the squeezing cylinders. There are two hose attachments, one for jarring and the other for ramming.

The machine illustrated is shown with the pattern plate and the pattern on the table. When the moulder shovels sand into the flask the jarring cylinder is started, and by the time the flask is filled the ramming is practically completed and the flask is ready for the bottom board. At this time the bottom board is put on and the head is swung around and the mould is squeezed. If desired the ramming head can be set ½ in. above the bottom board. The length of the squeezer stroke is 6 in. and that of the jarring stroke is regulated by the amount of air admitted.

Modern Cupolas.

The foundry cupola furnaces constructed by the Derby Boiler Company are recognised as being of first-class and modern design, with all parts substantially and well made. But special attention might be called to the method of opening and closing the top row of tuyers by means of a hand wheel operating a sliding cover, and also to the fastenings



SECTION THROUGH AIR-BELT OF DERBY BOILER COMPANY'S CUPOLA.

of the inspection-hole covers by means of wing nuts, which can be screwed up to make the cover air-tight. In the accompanying sketch a section of the cupola through the air-belt and tuyere is shown. The advantages of the foregoing features need not be laboured before foundrymen.

It may be mentioned that the London agents for the firm are Murphy, Stedman & Company, Limited, Gamage Buildings, Holborn, E.C.

"Sign-it" Time Recorder.

A somewhat unique time recorder is being placed on the market by Time, Limited, 48, Dover Street, London, W., the principle being that the employés each sign the apparatus and thus any possibility of "faking" is prevented, as it is impossible for one person to sign and a different person to register the time. Therefore, in branch establishments, collusion in time-keeping where there is no supervision is rendered quite impossible

THE "SIGN-IT" TIME RECORDER.

The handy size of these recorders enables them to be placed wherever required, right at the scene of work or out on a job. Further, there is no limit to the capacity of each recorder.

This system of making every man his own time-keeper has obvious advantages, while, also, for night watchmen, it ensures that the watchman himself and not a substiute, records his rounds.

A feature of the apparatus is the few parts, which are standardised; the whole clock mechanism can be removed easily if required to clean. The accompanying illustration shows the external view of the recorder.

Newcastle-on-Tyne Foundrymen's Visit.

On Saturday, September 21, the Newcastle and District Branch of the British Foundrymen's Association paid a visit to the works of Messrs. Smith & Company, Nile Street Foundry, South Shields. Some 50 or more members availed themselves of the firm's kind invitation, and a most enjoyable afternoon was spent. On arrival at the foundry the party were met by Mr. James and Mr. Edward Smith, and conducted around the various shops and departments. Some very heavy work was in hand in various stages, and the members were highly interested in all they saw, the overhead crane equipment being specially admired. Messrs. Smith had also arranged with the Corporation officials for the members to inspect the Corporation's electricity works close by. The party were received by the chief electrical engineer, Mr. H. S. Ellis and Mr. Robertson, and were conducted round the works. A very interesting hour was spent there, and the appreciation of the members were recorded by a vote of thanks, to which Mr. Ellis suitably responded, and was good enough to tender another invitation. Messrs. Smith now took the party in hand again, and dispensed hospitality at a local restaurant. At the conclusion of tea the Branch President, Mr. Wallis, proposed a vote of thanks to Messrs. Smith; this was seconded by the Vice-president, Mr. J. Weir, and carried unanimously. Mr. James Smith replied on behalf of the firm, and also gave a report of his recent visit to Birmingham on Association business.

D

Inventions.

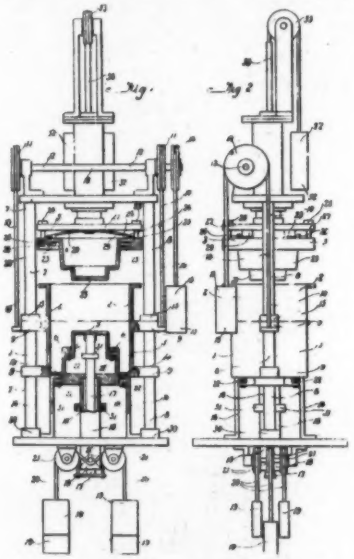
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

16,546. Furnaces of the Siemens' reversible regenerative type. A. Reynolds.
16,879.*Machine for measuring directly the hardness of metals. R. Guillery.
16,884.*Manufacture of steel. A. M. Chretien.
17,014. Tempering steel. F. O. Bynoe and H. Edwards.
17,039.*Casting-machines to produce sash-weights. C. H. Lister.
17,051. Device for elevating liquids and solids. Sandycroft Foundry Company, Limited, and T. M. Dutton.
17,131.*Regenerative furnace with removable head. H. Rehmann.
17,227. Casting iron and other metals. I. E. Lester.
17,241. Burners for use with gas-fired furnaces. Selas Lighting Company, Limited and T. Brown.
17,756. **Heat treatment of metal bodies. J. H. Barker and Birmingham Metal and Munitions Company, Limited.**
18,181. Furnaces. A. Smallwood.
18,523. Open-fired furnaces for melting purposes. L. F. Tooth.
19,172.*Electric furnaces. Georges Massip.
19,287.*Electric furnaces. L. Gonnet.
19,389.*Sand-blast apparatus. H. Girvin and J. C. Myles.
19,552. Vacuum casting-machines. F. H. Wright.
19,657.*Casting metal ingots. F. Kohlhaas.
19,943.*Apparatus for melting, compressing, and forcing metal or alloys into moulds. W. G. Hanna, junr.
20,164. Casting or moulding boxes. A. Körting.
20,440. Moulding apparatus for moulding air-cooled motor cylinders. Willans & Robinson, Limited, and R. Watson.
20,788. Treatment of iron for foundry use. A. Rollason and T. S. Anderson.
20,884. Moulding flasks or boxes. (Percy Webster, United States.)

Abstracts of British Patent Specifications recently accepted.

14,791 (1911). *Moulding Machines.* A. Phillips, Claremont, Goldthorn Hill, Wolverhampton.—The invention relates to moulding machines wherein the sand is initially carried by a receiver and so arranged as to transfer the sand from the receiver to the moulding box during the process of ramming. A convenient form of this machine is described. Fig. 1 is a front elevation of the machine, the pattern and rammers shown in section, arranged for moulding from a pattern having two steps of projection from the plate which carries it, such as a lavatory cistern. Fig. 2 is a side view. 1 is the receiver, 2 the moulding box, 3 the pattern plate, 4 the fixed rammer, and 5, 6 the movable rammers. The receiver 1 is slidingly connected with the pillars 7, 8 such as by means of lugs 9 through which the pillars pass, and is held in position (such as by means of the flexible connectors 10, which are connected to the periphery of the pulley wheels 11 which are fixed upon the shaft 12 and the balance weight 13 fixed to the pulley wheel 14, which is also fixed to the shaft 12) against the stops 15, which are adjustable along the pillars 7, 8 and provide the means of adjusting the receiver 1 in its height in relation to the rammers 4, 5 and 6. The fixed rammer 4 is supported such as by the framework 16 and the movable rammers 5, 6 passing therethrough are supported such as by the legs 17, 18 which are in turn supported such as by balance weights 19, being connected thereto by means of the flexible connectors 20 passing over the pulleys 21. The movable rammers are adjustable in relation to each other, and to the fixed rammer, such as by the set screws 22. The pattern 23 is carried by the pattern plate 4, and 24 is an auxiliary rammer for ensuring the hardness of the face of the mould, slidable within the recess 25 of the pattern plate, and provided with projections 26 which pass through the pattern plate, and are of such length that when the ramming head 27 is in contact with the pattern plate 4 and the projections are in contact with the said ramming head, then the rammer 24 will be in its correct position in relation to the pattern 23 for the formation of the mould. The pattern plate 43, is connected to the ramming head 27, such as by means of the bolts 28 which pass loosely through the rammer head and are fixed into the pattern plate, and the rammer head and the pattern plate are prevented from coming in contact except under the desired pressure, such as by means of the springs 29 interposed between them. If it is not desired to give a particularly hard parting face to the moulds, it is obvious that an ordinary pattern may be used. Previously to putting the moulding box 2 in position, sand is supplied to the receiver 1, the moulding box is then placed thereon, and the pattern plate 3 is brought down upon the box 2, the pattern 23 thereon projecting within the box; pressure is then brought upon the pattern plate, and the box and receiver are forced down in relation to the sand and the rammers within the receiver and the pattern is forced somewhat into the sand; the continued downward movement presses the pattern upon the sand, and moves down the movable rammers 5, 6, such rammers being moved down together with

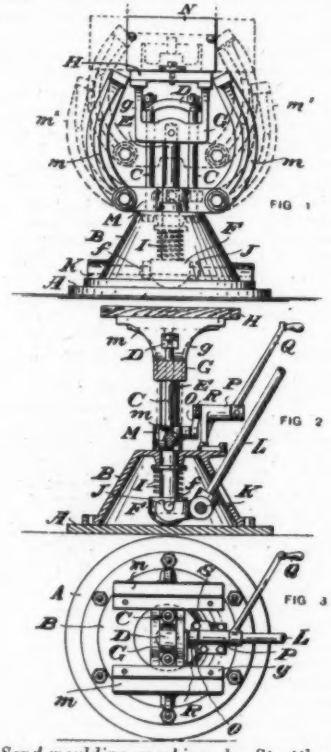


Moulding Machine, by Phillips.

the receiver 1, and moulding box 2; the sand between the movable rammers and the walls of the receiver is pressed within the moulding box and around the pattern and pushes back the rammer 24 within the pattern plate 3. The further downward movement of the ramming head 27 forces down the rammer 24 within the pattern plate 3 through the medium of the projections 26 and firmly rams the face of the mould, the springs 29 allowing such further motion notwithstanding the receiver is upon its fixed stop. The pressure is now removed, and plate 3 and the pattern 23 are balanced back to their normal position, such as by means of the balance weight 32 and flexible connector passing over the pulley wheel 33 and connected to the extension 34 of the hydraulic ram. The receiver 1 is balanced back into position by weight 13 upon the pulley wheel 14, and the movable rammers are balanced back by the weights 19.

21,034 (1911). *Sand Moulding Machines.* S. Strettles, 12, Willows Crescent, Birmingham.—Fig. 1 is an elevation of the machine, Fig. 2 a sectional elevation at right angles to Fig. 1, and Fig. 3 a plan. The machine comprises a flat base-plate A and a cover B, on which are mounted two upright guide rods C for the pattern support as well as for the flask supports. These guide rods are joined at their upper ends by a cross-piece D, which maintains them at their proper

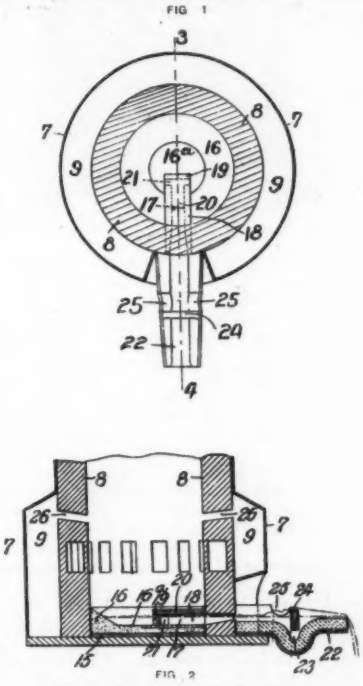
distance apart. The jolting or jarring mechanism comprises a ram E passing through the centre of the dished cover B, and provided with a knob or the like F at its lower end which strikes the vase-plate A when the ram is at the bottom of its stroke, and a cross-head G at its upper end. This cross-head is capable of sliding along the upright guide rods C and is provided with vertical arms *g* on which the pattern table H rests. Between the knob F and the dished cover B there is provided a helical spring I around the ram E. The knob F is furnished with lateral trunions *f* which are engaged by a fork J fulcrumed on a transverse shaft K secured at its ends in the dished cover B. The fork J is adapted to be moved up and down by means of a lever L extending through a slot in the dished cover B, and raises and drops the ram E supporting the pattern table. The flask raising mechanism comprises a cross-head M, also capable of sliding along the upright guide rods C, and provided with a hole for the passage of the jolting ram. To this cross-head are hinged arms *m* adapted to engage the stripping plate or the projecting walls of the flask N. The cross-head M, with the arms *m*, can be raised or lowered by means of a crank



Sand-moulding machine, by Strettles.

O, the pin of which engages a slot in the cross-head. The shaft of the crank O is supported in a suitable bearing P and is furnished at its other end with a handle Q. When the crank has turned past its highest position a projection R on the crank comes in contact with an adjustable stop like the screw S and maintains the arms *m* and the flask in their raised position. The hinged arms *m* can be moved closer together or farther apart as indicated at m^1, and clamped in the proper position to enable the machine to deal with flasks of various sizes within certain limits.

282 (1912). *Cupolas.* S. Barnes, 189, St. James Street, Montreal, Canada.—This invention is particularly designed for use in connection with low blast pressures and continuous melting. Fig. 1 is a sectional plan view of a cupola constructed according to the invention; Fig. 2 is a sectional elevation on the line 3—4 of Fig. 1. 7 designates the vertical metal shell of a cupola constructed in the conventional manner. A suitable fire brick lining 8 is built within the outer shell, and between the lining and the shell is located the annular air chamber 9, to which air is delivered through a tangentially arranged blast pipe not shown. The floor 15 of the cupola is made of firebrick on which is placed a sand bottom 16, which is inclined from the sides towards the centre so as to leave a flat circular central portion 16. The outlet channel or duct 17 at the bottom of the furnace extends approximately from the centre of the bottom of the cupola, and this channel is substantially T-shaped. It is formed of two brick side walls 18 and a transverse end wall 19, which is located a short distance from the ends of the side walls so as to form the T-shaped passage 17, which entire outlet conduit is covered with firebrick 20. The molten metal passes into the ends of the transverse part 21 of the conduit, that is at the ends of the head of the T-shaped portion and then flows through a longitudinal member of the T-shaped part into the spout 22, the latter having a suitable lining and provided with a depression or trap 23, above which a firebrick transverse bridge 24 is located so as to form a trap which retains any dross, slag, etc., which latter flows off through the side openings 25 in the top edge of the sides of the

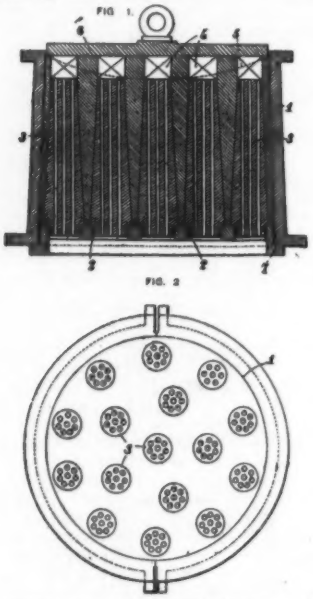


Barnes' Improved Cupola.

spout. As the outlet duct or conduit is provided with a top or cover, the air which enters the cupola through the tuyeres cannot blow the molten metal out through the outlet duct, and the metal accumulates in the disc-like bottom part of the cupola and flows through the duct into the spout continuously as produced, thus permitting of feeding iron and coke into the cupola without stopping the flow of the molten metal. In a blast furnace or re-melting furnace it has already been proposed to provide the discharge duct with a transverse bridge so arranged as to form a trap which retains dross and slag. It will be observed that the T-shaped part 21 of the spout through which the molten metal enters the conduit is open at both sides. When the molten metal is just beginning to form in the bottom of the cupola, this T-shaped portion will be open to the air blast within the cupola, but as the air enters from both sides the pressure is practically reduced to nil on account of the two opposing forces. There will thus be no liability of the molten metal being

blown out of the spout. Furthermore, as the entrance to the conduit is located approximately at the centre of the cupola where the force of the air blast is reduced to a minimum, there will be no tendency towards undue cooling of the metal entering the conduit. Relief passages 26 for the air pressure within the cupola are provided in the usual manner.

10,666 (1911). *Converters for the Manufacture of Steel.* Société Anonyme des Forges et Fonderies de Montataire, 16, rue le Peletier, Paris. Fig 1 is a vertical section of the mould employed for casting the mixture for a bottom with tuyeres (the arrangement is analogous for a bottom with pins); Fig. 2 is a plan view of the same apparatus. The lower plate 7 of the mould 1 comprises housings 2 intended for retaining the tuyeres or perforated magnesia blocks 3. Iron wedges 4 are arranged upon these tuyeres for enabling the mixture to extend by some centimetres beyond the top of the tuyeres, in such a manner that the latter always remain embedded in the mixture, notwithstanding the shrinkage caused by the heating and which imparts to the upper face of the converter bottom the form indicated by the broken line 5. The cover 6 is



Converter for the Manufacture of Steel.

then placed upon the mould, and the whole is left for about two days in a stove, the temperature of which is raised progressively from 300 to 400 deg. Cen., care being had not to ignite the tar. The bottoms of converters manufactured by this process are less costly than the others, and they permit of making from 15 to 30 per cent. more castings per bottom than with rammed bottoms.

25,711 (1911). *Casting of Metals or Alloys and Devices for use with same.* R. H. Carpmael, Bendower, Kenilworth.—This invention is applied to the casting of metals and alloys whose surfaces are covered with carbonaceous material whilst being heated. After the metal or alloy has been melted in the furnace the carbonaceous material is removed, and one or more vessels each containing a substance of which the melting point is known are floated on the surface of the molten metal. Preferably the metal or alloy is removed from the furnace before the vessels are floated on the surface. When two vessels containing substances of slightly different melting points, say, 5 degrees C., are used, it is easy to ascertain if the temperature of the molten metal is between the temperatures of the melting points of the two substances. The vessels may conveniently be dishes and are made of porcelain, platinum, or other material which does not combine with the molten metal.

17,179 (1911). *Manufacture of Electric Steel.* V. Stobie, of the Stobie Steel Company, Warren Street, Sheffield.—The invention is carried out by completing electric steel processes by either of the two following methods: the first being preferably followed if desulphurising by the finishing slag is not required, and the second preferably when desulphurising and deoxidising are both required. The following is the first method:—Any usual finishing slag may be placed on the bath, but preferably one composed of about 60 per cent. to 70 per cent. lime and 30 per cent. to 40 per cent. fluor-spar. Sufficient carbon is thrown on this slag when fluid to free it from any oxide of iron held by it. The quantity necessary will vary with the iron oxide held by the slag, which, in turn, will vary with the oxidised state of the bath, the time the slag has been thereon, and the heat of the furnace. The desideratum is to quite free the slag from iron oxide whilst maintaining the slag as fluid as possible by having little excess of carbon or other slag deoxidant. When the slag has thus been free from iron oxide, aluminium is introduced into the metal. The quantity of aluminium will depend upon the oxidised state of the steel; samples taken from the bath in the usual way will indicate when the metal is ready for tapping. The second method reads:—This process is similar to the above except that an ordinary finishing slag, composed of, say, 60 per cent. lime, 15 per cent. each sand and spar, and 10 per cent. carbon, is allowed to desulphurise in the usual way for some time, during which some deoxidation will also proceed; the process being completed as by the first method as soon as desulphurising is sufficiently effected. By this method some small quantity of silicon will, however, enter the bath. The steel must be kept in the furnace a minute or two after deoxidation, when only most minute traces of aluminium will be found in the metal. The minute or two rest gives the alumina produced sufficient time to slag out of the bath. Aluminium estimates on steels thus produced have shown .00 per cent. to .01 per cent. aluminium. By the use of aluminium the time required for finishing steel in an electric furnace will be curtailed by 20 to 80 per cent.

18,406 (1911). *Refining Molten Pig-Iron for Steel Making.* T. Twynam, Wynyard House, Redcar.—For the reduction of silicon and sulphur from molten pig-iron, the presence of a highly basic slag is essential, and it is possible in the steel-converting vessel or furnace to remove sulphur by the aid of a very highly basic slag, although with difficulty and with the expenditure of considerable time, and a large increase in slag volume. It is, therefore, far more economical to remove as much as possible of the silicon and sulphur contents of the pig-iron before this reaches the steel furnace, and for this purpose the inventor proceeds as follows:—Molten pig-iron is allowed to run either from the blast-furnace runner, or from the ladle, into an intermediate receiver furnished with a perforated bottom, the bottom being preferably lined with magnesia bricks perforated with holes or slits, of as small a diameter as is found practically possible to use without undue skulling. Into this intermediate receiver, fine dry carbonate of soda is fed, simultaneously with the molten pig-iron to be refined, so that the latter, when flowing through the holes or slits in the bottom or lower portion of receiver, drags with it the carbonate of soda, by which means an extremely intimate mixture of the alkaline salt with the pig-iron is brought about, which results in the almost instantaneous removal of a very large percentage of the silicon and sulphur contained in the pig-iron. The removal of the sulphur appears to be facilitated by the presence of the manganese in the pig-iron treated, as the resulting slag contains a considerable percentage of manganese oxide. After passing through the holes or slits of the receiver, the refined metal is caught in any suitable vessel and transferred therefrom to the mixer, furnace, or converter, care being taken that the alkaline slag is separated as completely as possible before entering the finishing furnace or converter. When it is desired to remove phosphorus, or to act more energetically on the silicon, a mixture of finely-powdered rich iron ore is added with the carbonate of soda, the material being added to the molten pig-metal as above. The iron oxide should be in extremely fine powder, and should be intimately mixed with the carbonate before use.

Trade Talk.

MR. H. E. THOMAS has acquired the Cardigan Engineering Works, Cardigan.

AN engineering and allied trades exhibition will be held at the Coliseum, Bristol, in February, 1913.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, have opened a branch office at 25, Suffolk Street, Dublin.

A FIRE broke out recently in the foundry of Messrs. J. Round & Sons, Sheffield, but only slight damage was done.

RICHARD THOMAS & COMPANY, LIMITED, are about to extend their steel works at Llanelly by the erection of several additional furnaces.

THE capital of the Frodair Iron and Steel Company, Limited, is to be increased to £150,000 by the creation of 75,000 6 per cent. preference shares.

MESSRS. LLOYD WISE & COMPANY, consulting engineers, 46, Lincoln's Inn Fields, London, W.C., have removed to 10, New Court, Lincoln's Inn, W.C.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY, LIMITED, have lately considerably extended their works at Cambridge, and a new shop is now operating.

THE co-partnership of the Linwood Foundry Company, of which Messrs. J. Stewart and O. Cochran were the partners, at Linwood, near Paisley, expired on August 31.

THE Registrar of Joint Stock Companies at Edinburgh gives notice that unless cause to the contrary is shown, the Clyde Brass Foundry Company will be struck off the register.

MESSRS. HUNT & MITTON, engineers and brassfounders, of Oozells Street North, Birmingham, have acquired the business of Fletcher Brothers (1908), Limited, of Ashton-under-Lyne.

BRETT'S PATENT LIFTER COMPANY, LIMITED, of Coventry, and William Jacks & Company, of Glasgow, have been elected members of the British Chamber of Commerce in Paris.

WAGSTAFF, MUSGROVE & COMPANY, LIMITED, Hamilton House, Bishopsgate, London, E.C., have been appointed export agents for R. Gumm & Company, G.m.b.H., Remscheid, Germany.

PROFESSOR LOUIS, of Armstrong College, has intimated his willingness to consider conducting a course of lectures for foundrymen, provided sufficient members and students are forthcoming.

THE erection of three new furnaces at the Port Talbot Steel Works has been commenced, and new sidings are being laid from the Port Talbot Station into the works for the conveyance of materials.

WALTER SLINGSBY & COMPANY, LIMITED, of East Parade, Keighley, have purchased a site with an area of five acres on which to erect new works on the outskirts of the town, adjoining the railway.

MESSRS. R. G. & F. A. JONES, carrying on business as engineers, toolmakers and merchants, at Trafford Weint, South John Street, Liverpool, under the style of Gibson & Jones, have dissolved partnership.

E. G. WRIGLEY & COMPANY, LIMITED, engineers, of the Foundry Lane Works, Soho, Birmingham, have established a London branch at 28, Victoria Street, Westminster, S.W., under the charge of Mr. W. T. Day.

THE partnership heretofore subsisting between Messrs. A. Chatwin, J. Chatwin, and T. Chatwin, carrying on business as engineers' tool manufacturers, at Victoria Works, Great Tindal Street, Birmingham, under the style of Thomas Chatwin, has been dissolved.

SAMUEL WARREN, LIMITED, steel manufacturers, of Sheffield, have received an intimation from the Admiralty that their name has been placed on the list of those firms who will be invited to tender for all descriptions of crucible steel, including high-speed tool steel.

MESSRS. H. E. SHAW and P. J. WESTON, carrying on business as brass casters and brass finishers, at St. Ann's Road, Willenhall, under the style of "H. E. Shaw" and "Shaw and Weston," have dissolved partnership. Debts by H. E. Shaw, who will continue the business.

MR. H. GIELGUD, of 7a, Laurence Pountney Hill, London, E.C., has transferred the agency the Société Anonyme des Acieries d' Angleur of Tilleur, Belgium, to Messrs. Andrew Brown & Company, and the business of the agency will be carried on by that firm at the same address.

THE capital of the Chesterfield Tube Company, Limited, has been reduced, and is now £80,000, divided into 75,000 cumulative preference shares of £1 each and 100,000 ordinary shares of 1s. each, instead of the original capital of £175,000 divided into 75,000 cumulative preference shares of £1 each and 100,000 ordinary shares of £1 each.

IT is notified in the "Gazette" that orders were made on August 13, 1912, restoring the Letters patent granted to Montague Moore and Thomas James Heskett for "An improvement in the direct process of manufacturing iron and steel," numbered 17,131 of 1906, and bearing date July 30, 1906; for "Improvements in apparatus for treating ferruginous ore for the manufacture of iron and steel therefrom," numbered 5,041 of 1904, and bearing date March 1, 1904; and for "An improved process of and apparatus for treating ferruginous ore for the manufacture of iron and steel therefrom," numbered 4,975 of 1904, and bearing date February 29, 1904.

THE stern frame of the new White Star liner, which will surpass in size the "Titanic," was on September 15 despatched from Darlington to West Hartlepool for shipment to Messrs. Harland & Wolff's yard at Belfast. The Darlington Forge Company, Limited, who performed similar work for the "Titanic," were entrusted with the casting of the still larger frame of the new ship. It was made in two sections, weighing in all about 75 tons. The task of conveying the frame by rail to West Hartlepool was, naturally, rendered exceedingly difficult. It was loaded on two wagons, and, as the ends projected several feet, two lines had to be cleared for its transit.

SOME interesting features are embodied in a large foundry ladle of the Derby Boiler Company's make, recently supplied by Murphy, Stedman & Company, Limited, Gamage Buildings, Holborn, for the foundry of a well-known engineering works in the South of London. The gearing of the ladles, the gear wheels, the worm, and also the housing or gear box, are of steel, and unbreakable with legitimate use. It is considered that this is a considerable advantage over cast-iron. Another important point is the length of the grip which the gear case has on the hanging bar; in the majority of ladles this is short, and is secured by two bolts, with the consequence that the gearing frequently comes loose and causes trouble. In the Derby Boiler Company's pattern the grip of the hanging bar is 7 in. long upwards, and is secured by four or six bolts. As a result, it is impossible for gearing to come loose, thus rendering pouring more certain and safe. Murphy, Stedman & Company, Limited, are also supplying a large foundry cupola of the same company's make to the Cannely Foundry Company.

A MEETING of the creditors of Messrs. Samuel Buckley & Sons, Admiral Steel Works, Hillsborough, Sheffield, was held in Sheffield recently. There was a large attendance of creditors, and Mr. Arthur Balfour, of the firm of Messrs. Seebohm and Dieckstahl, Limited, was voted to the chair. A statement before the meeting showed that the amount owing to unsecured creditors is £15,169 19s. 5d.; to partly-secured creditors, £12,873 6s. 1d., less value of securities £4,131 10s., leaving £8,741 16s. 1d. to rank against the estate. The total liabilities expected to rank for dividend amounted to £23,911 15s. 6d. The value of the assets is estimated at £20,954 19s. 3d., but there are various important questions to be decided which may seriously affect this total, and will probably considerably increase the deficiency. The heaviest unsecured creditors are Arthur Lee & Sons, Limited, Crown Steel and Wire Mills, Sheffield; the Sheffield Forge and Rolling Mills Company, Limited, Millsands, Sheffield; and Seebohm and Dieckstahl, Limited, Dannemora Steel Works, Sheffield. It was arranged that there should be a deed of assignment, and a committee of inspection was appointed.

Queries.

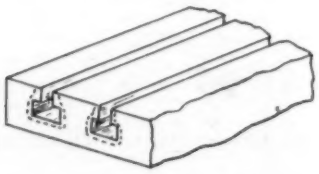
Lapping Piston Rods with Gun-Metal.

Will you please inform me how to lap piston rods for the vacuum brake with gun-metal so as to get them without blowholes? We skin-dry the tops and drags and make the iron red hot, but only get about 10 per cent. good. Is there not some way of coating the iron in order to get good results?

"Brass Moulder."

Denseness in Machine-Tool Castings.

I should like to call your readers' attention to an advertisement appearing in an American trade paper by a well-known American firm of machine-tool makers, which says:—"The iron in our tables is condensed around the T slots, making them strong and durable. There is no sponginess. The metal at the bottom of the slots is as good as at the top." Can you, or any of your readers, throw light on



what is meant by the term "condensed," or, in other words, do you know of any process for making the interior of a casting 2 or 3 in. thick as close-grained and solid as it is on the outside? As no doubt many of your readers have produced this class of casting, it would be instructive to hear what some of them have to say on the subject.

"Interested."

NORTHAMPTON POLYTECHNIC INSTITUTE.—St. John Street, London, E.C.—We have received from Dr. R. Mullineux Walmsley, Principal of this Institute, the annual volume of announcements, educational and social, for the Session 1912-1913. As regards new developments at the Institute, the equipment has been steadily extended since last year, but there is no large item like a new generating station to report on this occasion. Many changes and extensions have been made throughout, however, to bring the equipment up-to-date. In the mechanical engineering department the equipment for experimental work in aeronautics has been considerably augmented, and a new steam power plant has been laid down, which will enable students to experiment on the efficiency of steam plant from the coal and water to the brake of the engine with measuring appliances at every stage. In other departments important additions have also been made. In the evening classes in the mechanical engineering department the courses in aeronautical engineering have been further developed, especially on the experimental side. The half-time trade courses in technical chemistry and in horology inaugurated last session are being further developed. In these classes the students, all of whom are engaged in commercial workshops, are in attendance from 9 a.m. to 1 p.m., and spend the afternoons in their employers' workshops. The experiment appears to meet the needs of the particular trades mentioned, and if it continues to be as successful as in the past year it will probably be extended to other trades.

The late Mr. William Yates, who was chairman of Yates & Thom, Limited, Canal Foundry, Blackburn, left estate of the gross value of £110,925, of which the net personalty has been sworn at £94,155.

Personal.

The King has appointed the Duke of Devonshire to be Knight Grand Cross of the Royal Victorian Order.

Mr. J. B. Corrie has, we understand, been elected a director of H. Bessemer & Company, Limited, Sheffield.

The gross value of the estate of the late Mr. C. Bevitt, of John Bevitt & Son, ironfounders, of Pontefract, is £7,634.

Mr. Samuel Osborne, of Samuel Osborne & Company, Limited, steel manufacturers, of Sheffield, has been invited to become the next Lord Mayor of Sheffield.

The gross value of the estate of the late Mr. William Allman, managing-director of Cope & Timmins, Limited, brassfounders, of Birmingham, is £10,315.

The late Mr. Henry Lea, of Messrs. Henry Lea & Son, consulting engineers, Birmingham, has left estate valued at £14,118 17s. 10d., with net personalty £13,990 19s. 3d.

The gross value of the estates of the late Mr. C. H. Bagshaw, of J. Bagshaw & Sons, Limited, engineers, of Batley, is £3,917, which included £3,893 net personalty.

Sir Robert Hadfield, F.R.S., is the subject of No. 2,288 "Men of the Day" in a recent issue of "Vanity Fair," which includes an excellent coloured sketch of the popular Knight.

The gross value of the estate of the late Mr. A. C. Boyd, a director of Bolckow, Vaughan & Company, Limited, is £67,401 6s. 6d., of which the net personalty has been sworn at £52,898 11s. 4d.

Mr. R. R. Bevis has resigned his position as managing director of the shipbuilding and engineering works of Cammell, Laird & Company, Limited, Birkenhead. Mr. Bevis will retain his seat on the board.

The late Mr. J. C. Bull, managing director of Bull's Metal and Melloid Company, Limited, who died at Christiania, Norway, on April 6 last, left personal estate in the United Kingdom valued at £10,130.

The late Mr. James Dunn, formerly senior constructor and assistant director of naval construction to the Admiralty and a director of Vickers, Limited, left estate of the gross value of £26,081, of which £25,368 is net personalty.

Mr. G. J. Carter, one of the local directors of Sir W. G. Armstrong, Whitworth & Company, Limited, has resigned his position at Elswick in order to accept a seat on the board of Cammell, Laird & Company, Limited, of Sheffield and Birkenhead.

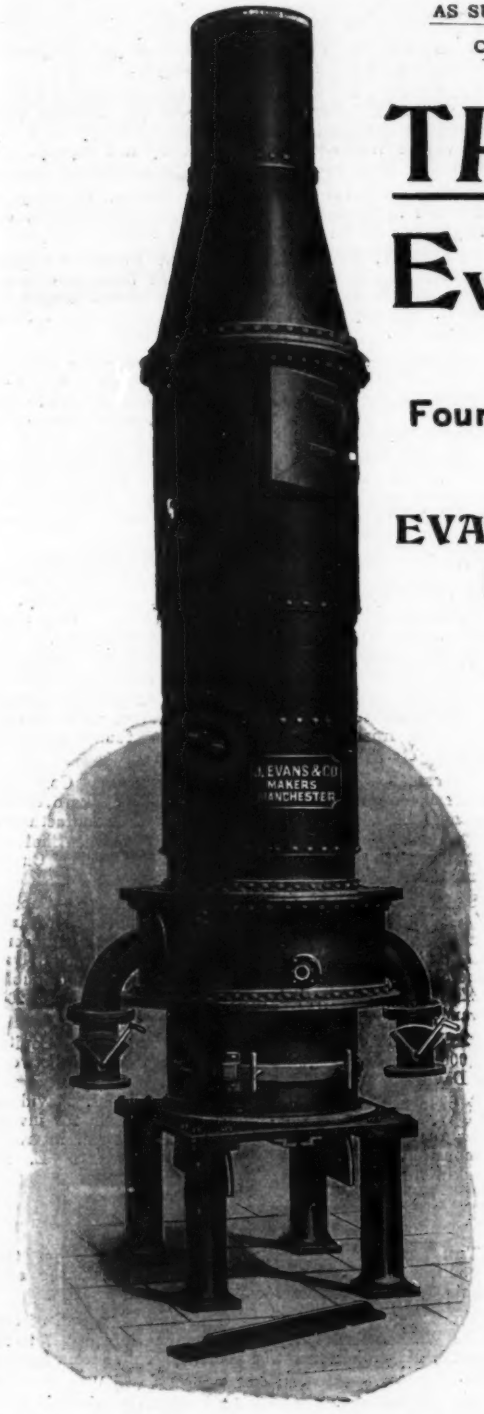
On August 21 last Mr. John Fritz, the Nestor of American iron and steel manufacturers, and the best beloved man in the American iron trade, completed his 90th year. Mr. Fritz is, of course, a sufferer from the infirmities of old age, but his mind is clear.

Engineer Rear-Admiral John Thomas Corner, formerly manager of the engineering department at Portsmouth Dockyard, and a director of Bull's Metal and Melloid Company, Limited, who died on August 5 last, aged 63 years, left estate of the gross value of £3,367, with net personalty £3,268.

Mr. James H. Boolds, who for the past twelve years has been shipbuilding director at the Naval Construction Works of Vickers, Limited, is retiring from the management of the shipbuilding department at the Barrow Works, but will be retained for duties in connection with the establishments of Vickers, Limited, at home and abroad.

Mr. J. Rossiter Hoyle, managing director of Thomas Firth & Sons, Limited, Norfolk Works, Sheffield, has been elected Master Cutler in succession to Mr. Arthur Balfour. Mr. T. W. Ward (of Thos. W. Ward, Limited) has been elected Senior Warden and Mr. W. H. Ellis (of John Brown & Company) Junior Warden. Mr. William Crosby, director of Edgar Allen & Company, Limited, has been elected a freeman of the Company.

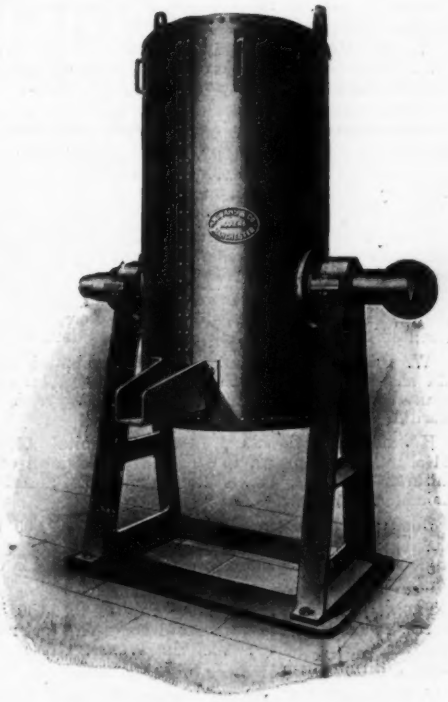
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.



THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

New Companies.

H. J. Hookham & Sons, Limited.—Capital £10,000 in £1 shares, to carry on the business of ironfounders, etc.

Pearson Garforth, Limited.—Capital £2,500 in £1 shares, to carry on the business of general ironfounders, etc.

Walton & Clough, Limited.—Capital, £8,000, in £1 shares (5,000 5 per cent. pref.), to carry on the business of engineers.

Oil and Gas Turbine Syndicate, Limited.—Capital £15,000 in 14,750 shares of £1 and 5,000 founders' shares of 1s.

Atoz Manufacturing Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc.

Denbigh Engineering Company, Limited.—Capital £5,000 in £1 shares. Registered office: 214, Horseley Heath, Tipton, Staffs.

Enanda Engineering Company, Limited.—Capital £1,000 in £1 shares. Registered office: Sumner Avenue, High Street, Peckham, S.E.

Cayley Robinson Furnace Company, Limited.—Capital £100,000 in £1 shares. Registered office: 57, Moorgate Street, London, E.C.

W. E. King, Limited.—Capital £500 in £1 shares, to carry on the business of engineers, etc. Registered office: Albion Works, Southwick, Sussex.

Allen & Timmins, Limited.—Capital £1,000 in £1 shares, to carry on the business of solder manufacturers, metal merchants and manufacturers, etc.

W. T. Moss & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of toolmakers. Registered office: Statham, Lymm, Cheshire.

Felber, Jucker & Company, Limited.—Capital £79,000 in £10 shares, to carry on the business of engineers. Registered office: 29, Peter Street, Manchester.

Landis & Gyr, Limited.—Capital £2,000 in £1 shares, to carry on the business of electrical and general engineers. Registered office: 28, Denman Street, S.E.

Jung & Dreydel, Limited.—Capital £6,000 in £1 shares, to carry on the business of engineers, etc. Registered offices: Bannister Road, Kensal Rise, London, W.

Hosking Brothers, Limited.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc. Registered office: Love Lane, Sumner Street, Southwark, S.E.

W. Procter & Ratcliffe, Limited.—Capital £500 in £1 shares, to carry on the business of gas, oil and gas plant engineers. Registered office: 75, Wyverne Road, Cardiff.

Houghton & Cowman, Limited.—Capital £5,000 in £1 shares (2,000 pref.), to carry on the business of agricultural engineers, etc. Registered office: Asfordby, Leicester.

Buckleys (London), Limited.—Capital £3,000 in £1 shares, to carry on the business of gas and general engineers, etc. Registered office: 434, Birkbeck Chambers, Holborn.

Thomas Chatwin, Limited.—Capital £50,000 in £1 shares, to carry on the business of engineers' tool makers, etc. Registered office: Victoria Works, Great Tindal Street, Birmingham.

T. Crossley & Company, Limited.—Capital £2,000 in £1 shares (1,250 five per cent. cumulative preference, 125 "A," 125 "B," and 500 ordinary), to carry on the business of engineers.

E. & F. Fawley, Limited.—Capital £2,000 in £1 shares, to carry on the business of iron merchants, mill, foundry and colliery furnishers, etc., and to adopt an agreement with E. Fawley.

Anglo Engineering Company, Limited.—Capital £3,000 in 1,000 cumulative preference shares of 10s., and 2,500 ordinary shares of £1. Registered office: 33, Kirby Street, Hatton Garden, E.C.

Finnieston Engineering Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of the Finnieston Engineering Company. Registered office. 169, Finnieston Street, Glasgow.

J. Kirby & Company (Leeds), Limited.—Capital £2,000 in £1 shares, to take over the business of a hydraulic and general engineer carried on by J. Kirby, at Vortex Works, Leeds, as J. Kirby & Company.

Hurd Coal Cutter and Engineering Company, Limited.—Capital £15,000 in £1 shares, to carry on business as engineers, ironfounders, boiler makers, etc. Registered office: 188, St. Vincent Street, Glasgow.

Kerswell, Faulkner & Hamlyn, Limited.—Capital, £6,000, in £1 shares, to carry on the business of metal workers, founders, machinists, engineers, etc. Registered office: Hanway Street Works, Tottenham Court Road, London, W.

Kasenit, Limited.—Capital £4,000 in £1 shares, to acquire a compound known as "Kasenit," used for hardening steel and other metals, and to adopt an agreement with E. M. Griffiths. Registered office: 1-3, Ludgate Square, London, E.C.

Duram, Limited.—Capital £25,000 (24,000 £1 ordinary and 20,000 1s. deferred), to carry on the business of electrical and mechanical engineers and manufacturers, and to adopt an agreement with C. Gladitz. Registered office 1, Broad Street Place, E.C.

Whittle (Birmingham), Limited.—Capital £2,000 in £1 shares, to take over the business of art metal workers carried on by W. E. Whittle and W. L. Broadway, at 131, Great Hampton Street, Birmingham. Registered office: 131, Great Hampton Street, Birmingham.

Blair Open Hearth Furnace Company, Limited.—Capital, £105,000, in 100,000 cumulative participating preference shares of £1 each and 100,000 ordinary shares of 1s. each, to carry on the business of furnace constructors, ironmasters, steel makers, founders, boiler makers, etc.

Sheffield Electric Steel Castings Company, Limited.—Capital £4,000 in £1 shares, to take over the business of a steel merchant and steel manufacturer's agent, carried on by Mr. G. Fischer, as the Sheffield Electric Steel Castings Company, at Melbourne Chambers, Cambridge Street, Sheffield.

S. Delcroix Engineering Company, Limited.—Capital £50,000 in £1 shares, to carry on the business of iron and metal workers, ironfounders, mechanical engineers, etc., and to acquire the business and assets of Sylvan Delcroix and C. Van Wymeersch, engineers and public works contractors, of Brussels. Registered office: 265, Strand, London, W.C.

Record Engineering Company, Limited.—Capital £5,000 in £1 shares, to adopt an agreement between J. Davidson and W. O. Larmuth and J. F. Adye for the acquisition of the patents granted to J. Davidson and W. O. Larmuth for the United Kingdom for inventions relating to improvements in steam traps, internal-combustion engines; also patents granted to E. L. Rankin for improvements in piston rings, etc.

The Linolite Company have acquired from the Woodhouse Steel Casing Company, Limited, the sole rights to manufacture steel casing and fittings.

The London office of Spear & Jackson, Limited, of the Etna Works, Sheffield, has been removed from 237 to 22 and 23, Mansion House Chambers, Queen Victoria Street, E.C.

Mr. O. Keyworth, at one time secretary of Hawksley, Wild & Company, Limited, boiler makers, Sheffield, has acquired the business, and in future will trade under the style of Hawksley, Wild & Company.

Messrs. Robert Walber & Company, iron merchants, 108, West Ferry Road, Millwall, London, E., have been appointed London and Eastern Counties agents of Austin & Dodson, Limited, crucible steel manufacturers, Cambria Works, Arundel Street, Sheffield.

CUPOLA BRICKS

FOR LINING
ORDINARY AND PATENT
CUPOLA FURNACES.

JOHN R. FYFE & Co.,
SHIPLEY, Yorks.

"ADAMANT CEMENT"

THE IRON CEMENT
FOR
FOUNDERS & ENGINEERS.

British Manufacture.

FREE SAMPLE AND PRICES FROM
SOLE MAKERS:—
CHARLES HALL & CO.,
NEWTOWN IRONWORKS,
Dixon Street, Dantzic Street,
MANCHESTER.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Deaths.

THE death occurred recently at Newcastle, of Mr. Henry March, a gentleman who at one time was prominently identified with the firm of Maclea and March, engineers, of Leeds.

MR. H. J. DAVIS, chairman of the Davis Gas Stove Company, Limited, of London and Luton, died recently in his 71st year.

MR. JOHN HARRIS, of Wellington Road, Bilston, died on September 18. For many years Mr. Harris, who was in his eightieth year, carried on the Britannia Iron Works, Bradley.

MR. TENNISWOOD MILLER, a member of the firm of Messrs. T. Miller & Company, engineers and electricians, 66, Victoria Street, Westminster, London, S.W., died last week at the age of 40 years.

PROFESSOR HERMAN F. WIEBE, the well-known German scientist, who was a delegate to the recent New York Congress of the International Association for Testing Materials, died on September 17, in New York.

MR. JAMES COATS, who had been chief draughtsman to Andrew Barclay, Sons & Company, Limited, Caledonia Works, Kilmarnock, for over thirty years, died at his residence, Dundonald Road, Kilmarnock, on September 14.

MR. JOSEPH A. BOORMAN, of The Knoll, Sherburn-in-Elmet, died recently at Blackpool. Mr. Boorman, who had resided at Sherburn for several years, was formerly the foreign representative for Greenwood & Batley, Limited, Leeds.

THE death took place at Birmingham on September 3 of Mr. William Shakespeare, one of the oldest and best-known solicitors in that city. In addition he, for some years, successfully carried on the Trent Iron Works at Frodingham, which formerly belonged to the late Mr. W. H. Dawes, a well-known Black Country ironmaster.

THE death is announced of Mr. G. S. Guy, J.P., which occurred at Great Malvern last month. Mr. Guy, who had been unwell for some time, was a well-known figure in Wednesbury, being chairman of James Russell & Sons, Limited, Crown Tube Works. He had been connected with the firm from its early stages, and had watched it grow to its present dimensions.

British Foundrymen's Association: Newcastle-on-Tyne Branch.

We are advised by the Hon. Secretary of this Branch of the British Foundrymen's Association that during the coming session there will be several "open" meetings, for which all members are invited to send in as soon as possible interesting points and questions, or short Papers of general interest for discussion. All questions, etc., must be submitted to Council at least two months before the meeting, in order to arrange a proper programme for the points to be discussed or debated upon. The first open meeting will be on the last Saturday in this minth.

MACFARLANE, STRANG & COMPANY, LIMITED, of the Lochburn Iron Works, and 204, St. Vincent Street, Glasgow, have removed their London office to 46, Queen Victoria Street, E.C., in consequence of the retirement of Mr. Gilchrist, who has acted as their London representative for the last 23 years. Mr. D. Gorse Glen will in future represent the company.

MR. W. HOWARD HEAD, of Barry, Head & Company, 110, Cannon Street, London, E.C., has resigned his position as joint managing director of the Bowesfield Steel Company, Limited, and Messrs. Barry, Head & Company, that of sole London and export agents to the same company, who are taking over the office at 110, Cannon Street. The London business of the Bowesfield Steel Company, Limited, will be under the management of Mr. John J. Goddard (Dorman, Long & Company, Limited.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

METALS.	End Sept., 1912.	End Sept., 1911.
Iron—Scotch pig warrants ton	*72/1	*52/3
—Middlesbro' warrants ton	67/2	46/1½
—W.C. M/nos Bessemer ... ton	84/0	64/0
—Stock, Scotch ... ... tons	1,060	1,000
Copper—Chili bars GMB ton	£79 2 6	£54 15 0
—Stock, Europe and afloat tons	49,468	66,914
Tin—English ingots ... ton	£234 10 0	£185 0 0
—Straits ... ... ton	£232 0 0	£177 10 0
—Stock, London, Holland. U.S.A., and afloat ...tons	12,213	16,174
Lead—English pig .. ton	£22 17 6	£15 7 6
Spelter—Ord. Silesian ... ton	£27 5 0	£27 15 0
Quicksilver (75lb)... bottle	£8 5 0	£6 12 6
Antimony—Regulus ton	£31 0 0 £32 0 0	£28 10 0
Aluminium—Ingot ... ton	£82 0 0	—

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 12 6	to	6 0 0
,, 3 to 4 in.	5 7 6	to	5 10 0
,, 5 to 8 in.	5 5 0	to	5 7 6
,, 10 to 16 in.	5 5 0	to	5 7 6
,, 18 to 24 in.	5 5 0	to	5 7 6
Chairs	4 7 6	to	4 10 0
Floor plates (open sand)	3 10 0	to	3 12 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 10s. 0d.; all per ton, f.o.b., London. Copper (clean), £70 10s. 0d.; brass (clean), £45 10s. 0d.; lead (usual draft), £20 10s. 0d.; Zinc, £21 10s. 0d.; all per ton delivered merchant's yard.

BLOFIL
THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
Unaffected by oil, steam, or water.
Sole manufacturers—
RUDD & OWEN
(DEPT. I)
HULL
Telegrams "Theripnene," Hull.
Telephone National 1223

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

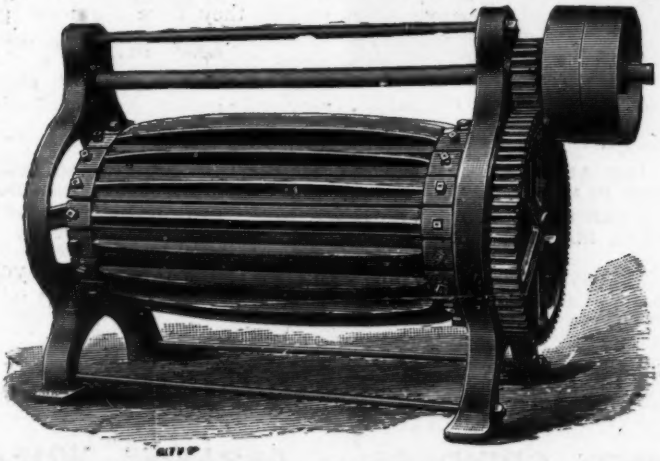
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Plate Moulding with Snap Flasks . .

is used extensively for dealing with light castings in all departments of the foundry trade. It is without question a very rapid method of moulding, and taken in conjunction with the fact that the snap flask does away with moulding boxes it is not surprising that the system is growing in favour. In point of output many power Moulding Machines can show an advantage over plate moulding, but this is over-balanced by the cost of the necessary boxes, the maintenance expenses and the floor space required for storing them.

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¶ The rate of production is such that no man with a plate and a snap flask can possibly compete. 200 moulds a day is quite ordinary and, in some cases, the rate of production with two men amounts to 400 moulds in eight hours.

¶ One firm to whom we have supplied several of these machines is obtaining four times the output they were formerly getting by plate moulding. ¶ Another is getting two and a half times the output, whilst a third is obtaining double the quantity of moulds they were previously getting from pneumatic machines.

¶ The following is some of the work that the machine is doing :—

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The machine will not make any and every casting, but if you will send us sample castings or drawings of your work we will tell you what it will do, or if you would like to see one of our representatives, we will arrange for a visit.

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658	Phillips, J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central
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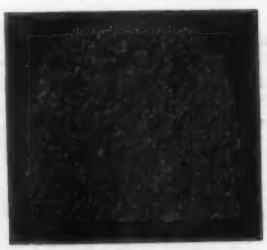
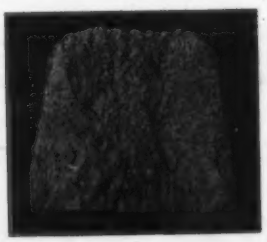
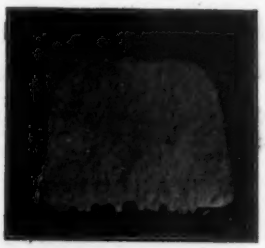

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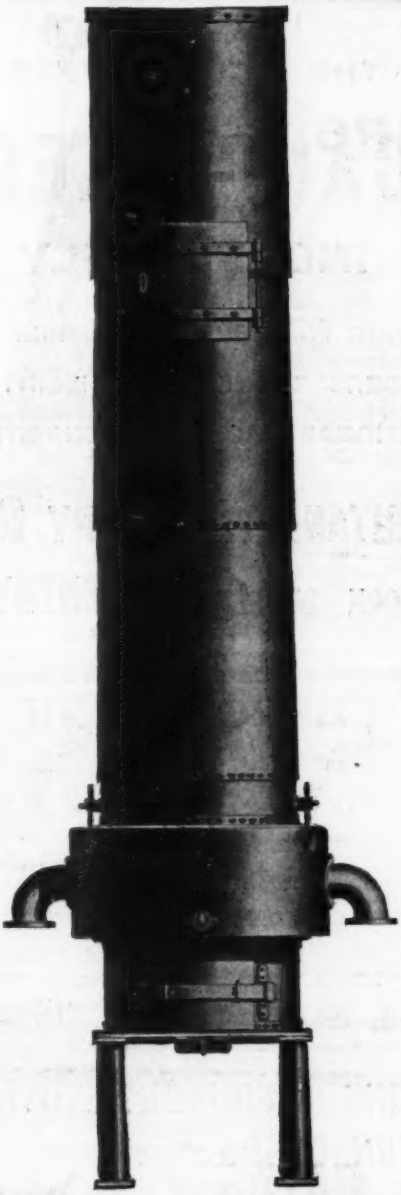

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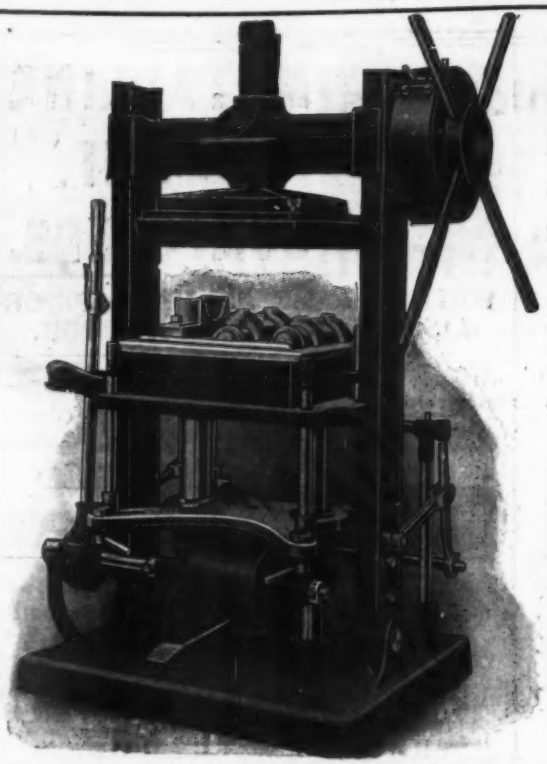

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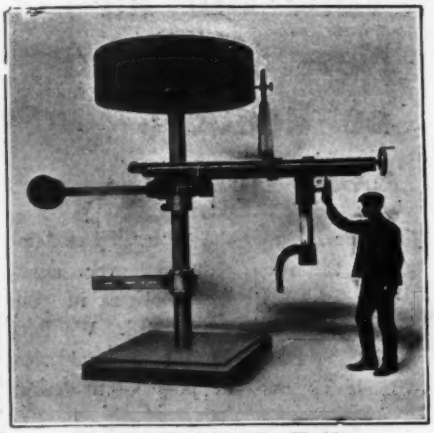

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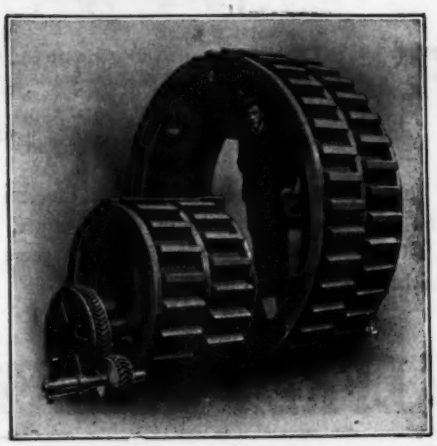

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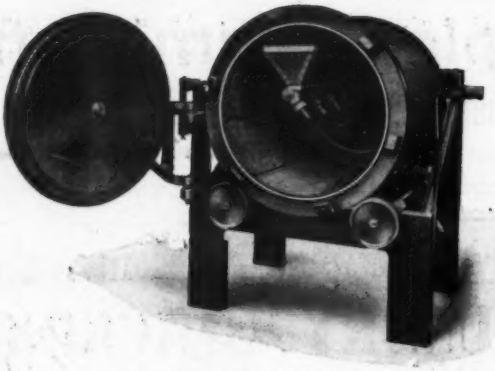

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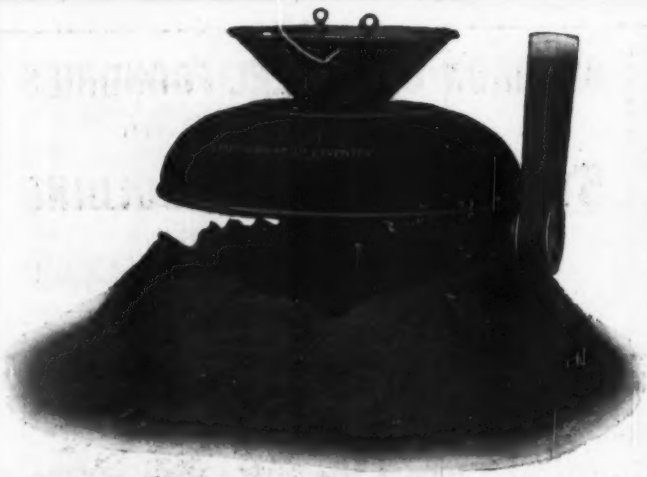

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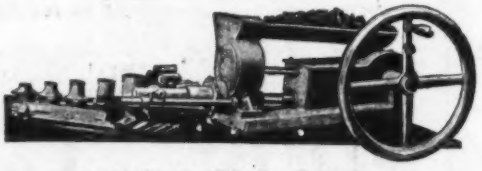

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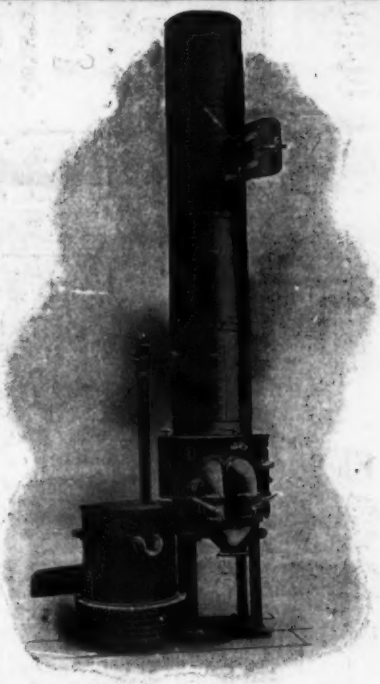

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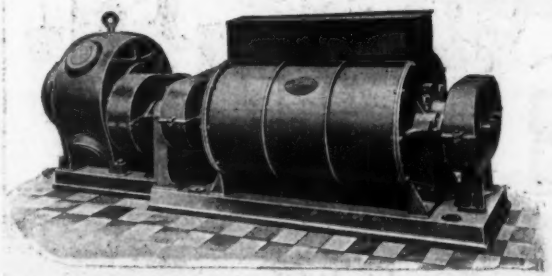

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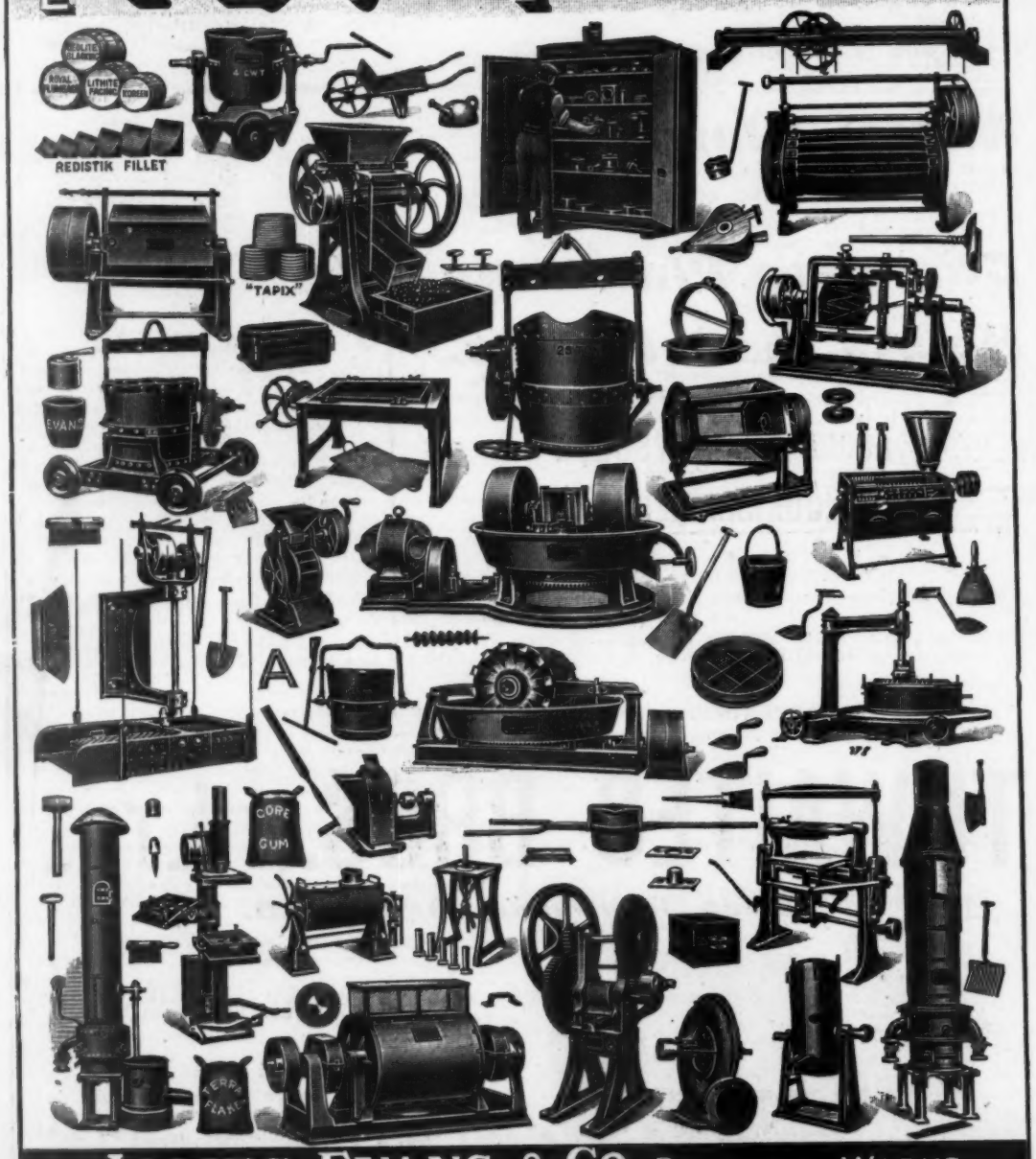
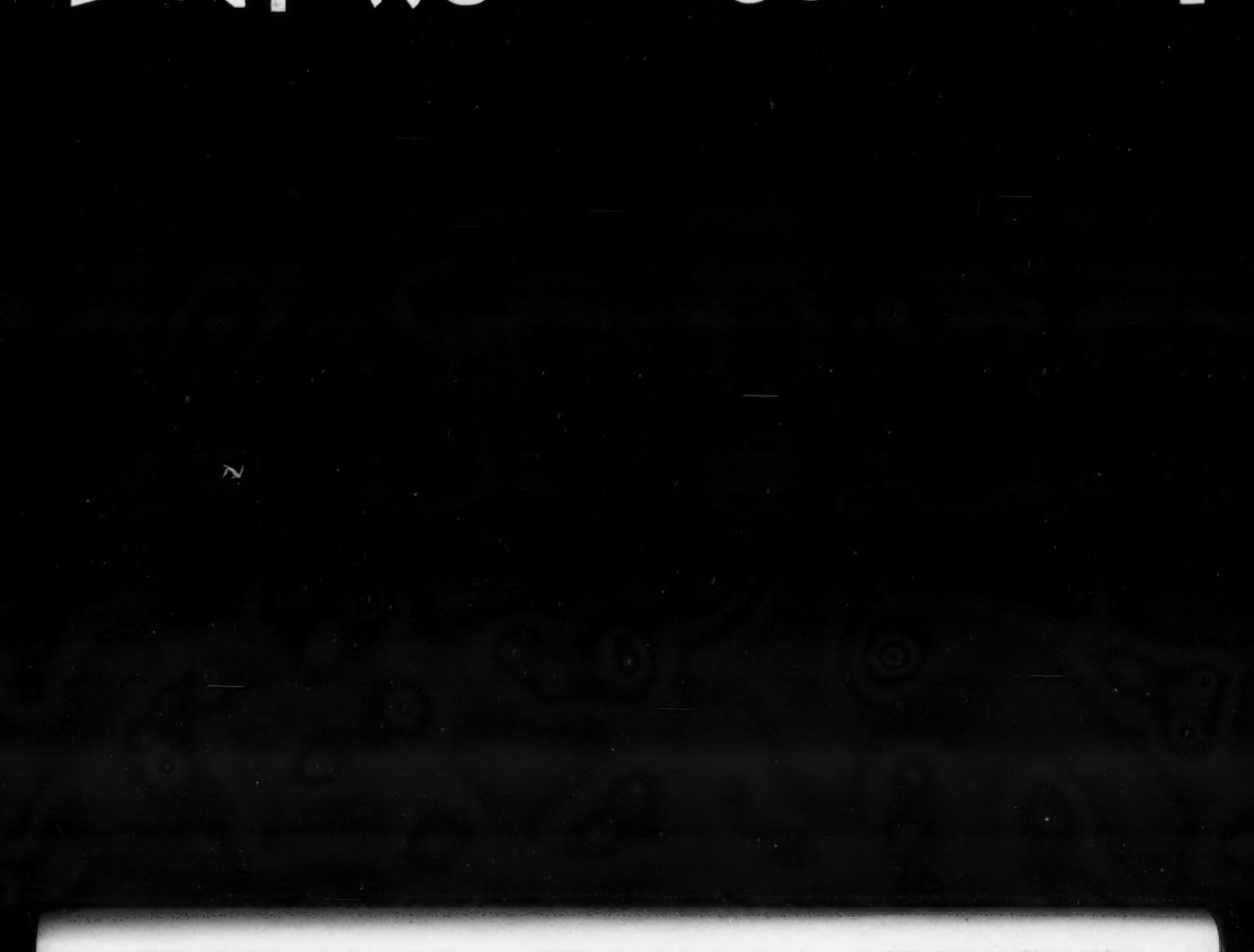
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